HWD Records Center

Signed 9-27-94

1.0

Final

EIELSON AIR FORCE BASE
OPERABLE UNIT 6

RECORD OF DECISION

Prepared for

Eielson Air Force Base
through
Armstrong Laboratory
Brooks Air Force Base
San Antonio, Texas

July 1994

CONTENTS

CONTENTS (continued)

RESPONSIVENESS SUMMARY

EIELSON AIR FORCE BASE
OPERABLE UNIT 6

DECLARATION OF THE RECORD OF DECISION

Site Name and Location

Operable Unit 6
Eielson Air Force Base
Fairbanks North Star Borough, Alaska

Statement of Basis and Purpose

This decision document presents the selected remedial action for Operable Unit 6 (OU6) at Eielson Air Force Base (AFB), Alaska, which was chosen in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act* (SARA), and, to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative Record for the site.

The State of Alaska concurs with the selected remedy.

Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Selected Remedy

The selected remedy for OU6 includes institutional controls to restrict the use of groundwater and groundwater monitoring to ensure protection of human health and the environment.

Major components of the OU6 selected remedy are

- monitoring the groundwater beneath and adjacent to the site to evaluate contaminant migration and natural attenuation (monitoring of OU6 will be incorporated in the Eielson AFB site-wide monitoring program)

- maintaining institutional controls that restrict access to groundwater and groundwater development at the site as long as hazardous substances remain on the site at levels that preclude unrestricted use.

These controls will remain in effect as long as the Air Force maintains active control of the area or until the groundwater contamination dissipates to levels that do not pose an unacceptable risk to human health or the environment. The specific institutional controls to be implemented at OU6 by land use controls are as follows:

1. development of a site map showing the areas currently and potentially impacted by groundwater contaminants to determine where the controls are to be implemented

2. posting of warning signs, prohibiting consumption and domestic use of the groundwater or the installation of additional wells for other than groundwater monitoring purposes;

3. continuing to provide an alternate water supply of potable water to OU6 for drinking and domestic use

4. securing of existing water supply and groundwater monitoring wells.

In addition, to ensure long-term integrity of the above land use controls, the Air Force will ensure that, to the extent that groundwater contamination remains above unacceptable levels, deed restrictions or equivalent safeguards will be implemented in the event that property containing such contamination is transferred by the Air Force.

Statutory Determination

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment to the maximum extent practicable. However, treatment of the groundwater was not selected due to the complex hydrogeology of the fractured bedrock, the limited extent of contamination in a remote area of the base, and the reliability of available institutional controls. Therefore, the remedy does not satisfy the statutory preference for treatment as a principal element.

Because the remedy will result in the continued presence of hazardous substances on the site above health-based levels, a review will be conducted within 5 years of commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

This signature page is part of Eielson AFB Operable Unit 6 Record of Decision, Final Version

Signature and Support Agency Acceptance of the Remedy

Thomas W.L. McCall
Deputy Assistant Secretary of the Air Force
(Environment, Safety, and Occupational Health)

9-27-94
Date

This signature page is part of Eielson AFB Operable Unit 6 Record of Decision, Final Version

Signature and Support Agency Acceptance of the Remedy

William D. McGee

William D. McGee
Regional Administrator
Northern Regional Office
Alaska Department of Environmental Conservation

8/11/94
Date

This signature page is part of Eielson AFB Operable Unit 6 Record of Decision, Final Version

Signature and Support Agency Acceptance of the Remedy

Jane S. Moore

for Chuck Clarke
Regional Administrator
Region 10
U.S. Environmental Protection Agency

9-27-94
Date

EIELSON AIR FORCE BASE
OPERABLE UNIT 6

DECISION SUMMARY

1. SITE NAME, LOCATION, AND DESCRIPTION

Eielson Air Force Base, covering an area of approximately 19,000 acres, is in the interior of Alaska, 100 miles south of the Arctic Circle, about 25 miles southeast of Fairbanks along the Richardson Highway (Figure 1). About 3,650 acres are improved or partially improved, and the rest encompasses forest, wetlands, lakes, and ponds. The base is bounded on the east and south by Fort Wainwright, a U.S. Army installation, and on the west and north by private and public land. The base is isolated from major urban areas. The adjacent public and private land is zoned for general use.

Eielson AFB, a major employer in the Fairbanks area, has approximately 3,400 military personnel and 500 civilian workers. The total residential population of the base is 5,132; the total population (living and working on the base) is approximately 10,000. The residential and occupational populations are primarily concentrated in the developed portion of the base. The base is active, with ongoing functions that include, in addition to the military mission, support work, school, and recreational activities. The base has three elementary schools and one junior-senior high school. There is one child care center and one medical and dental clinic.

The base is located in the Tanana River Valley, and most of the developed portion is built on fill material. The developed portion of the base is an area of low relief, with elevations averaging about 550 ft above sea level. The undeveloped east and northeast sides of the base are hilly, with elevations as high as 1,125 ft above sea level. Two-thirds of the base is on soils containing discontinuous permafrost. Half of the potential agricultural soils are currently being used for recreation facilities, ammunition storage areas, the Arctic Survival Training School, and other Air Force developments. Animals are abundant on Eielson AFB. The base supports a variety of recreation and hunting opportunities. There are no resident threatened or endangered species of plants and animals on the base.

OU (Operable Unit) 6, in the southeast corner of Eielson AFB (Figure 2), consists of a ridgetop where eight 50,000-gallon above-ground fuel tanks stored diesel and jet fuel from 1956 to 1972, the hillside below it, and the base of the hill, where there is a ski lodge and a skeet range at the edge of the Tanana River plain. The tanks were removed in 1977; in 1986 evidence was found that there had been releases of fuel into a fractured-bedrock aquifer in the ridge. Contaminated water flowed from there down to the alluvial floodplain aquifer. The latter contains an unknown but probably large amount of permafrost down to about 120–150 ft below the surface at the site.

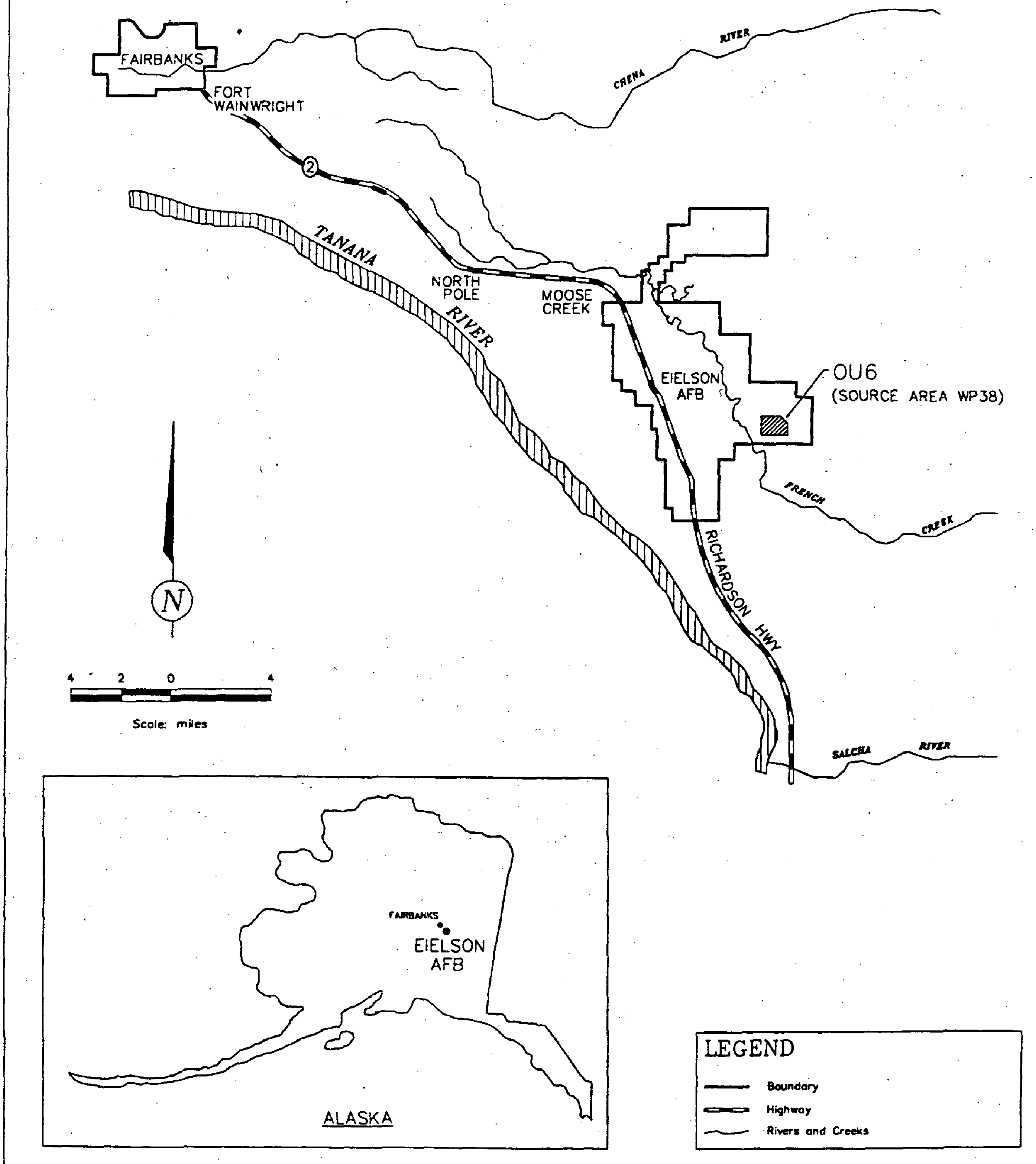

Figure 1. Eielson Air Force Base, Alaska.	Drawn:	Date:
	Reviewed:	Date:
	Rev.1:	Date:
	Final:	Date:

F:\AJW\EIESON\VICINITY.DWG

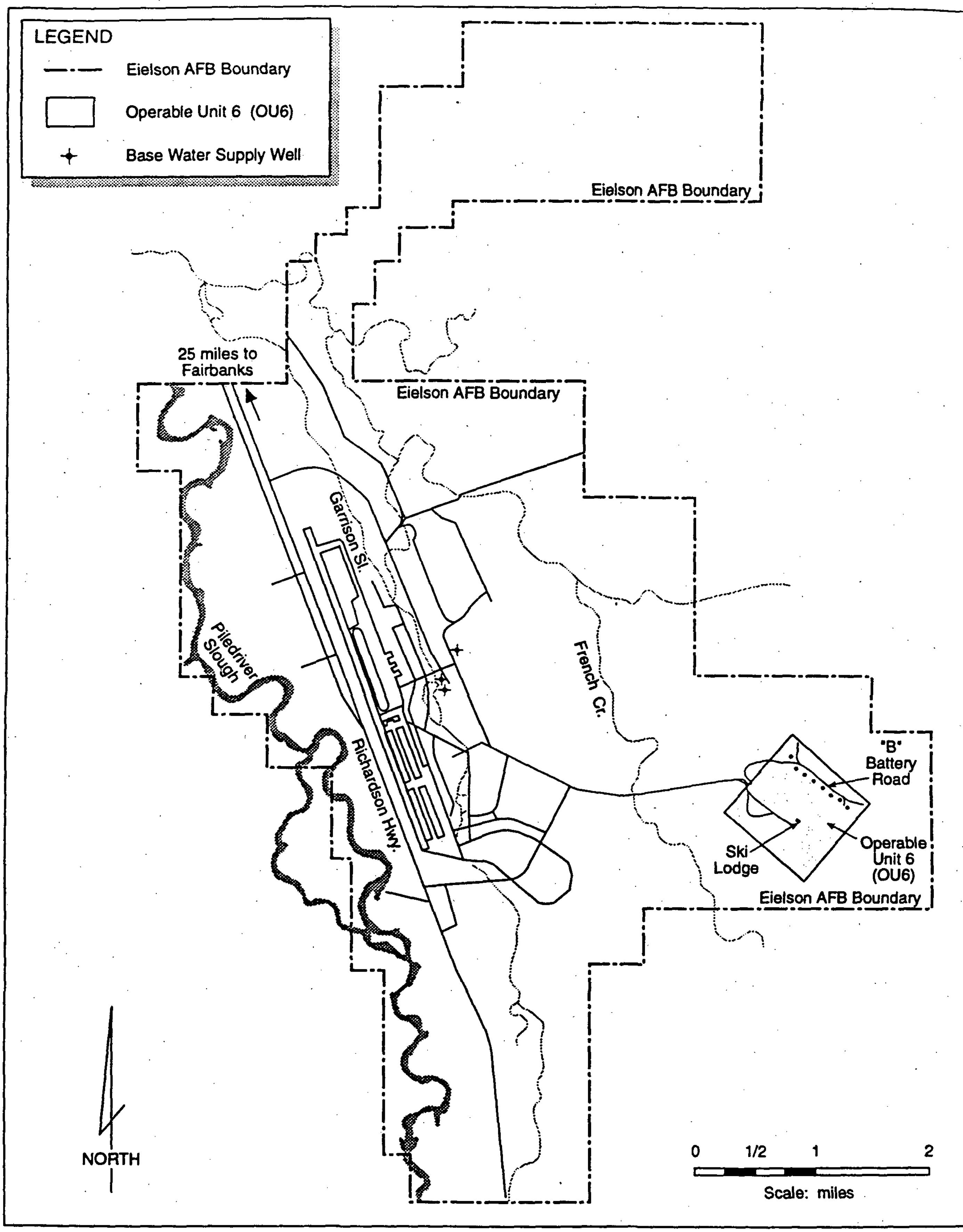

Figure 2. Map showing location of Operable Unit 6, Eielson Air Force Base.

Drawn	AJW	Date	4/18/94
Reviewed		Date	
Rev		Date	
Final		Date	

Beneath the developed portion of the base the floodplain aquifer is shallow and unconfined in 200–300 ft of unconsolidated alluvial sands and gravel overlying bedrock of relatively low permeability. This aquifer is characterized by high transmissivities and relatively flat groundwater gradients. There is evidence of discontinuous layers of permafrost in it. Although there are seasonal fluctuations, groundwater is generally encountered about 8 ft below grade, and it flows generally to the north-northwest, locally influenced by surface water bodies (e.g., French Creek, Garrison Slough) and groundwater extraction from the base supply wells.

Groundwater is the only source of potable water at the base and in the communities near it. Potable water in the main base system is treated to remove iron and sulfide. The aquifer is also the principal source of water for various other industrial, domestic, agricultural, and fire-fighting uses.

2. SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 SOURCE AREA WP38 (OU6)

2.1.1 Site History

Operable Unit 6 is a single contaminated source area, also referred to as WP38, located in the southeastern area of the base. This OU includes approximately 200 acres of southwest-facing hillside near the Eielson AFB Ski Lodge (Figure 3). Present uses of the area include downhill and cross-country skiing, winter survival training, snowmobiling, and setting of permitted trapping lines.

The immediate source area was a fuel storage area built in 1956. Eight 50,000-gallon above-ground tanks and a number of smaller tanks were located on the crest of the ridge, along the southwest side of "B" Battery Road. The tanks were used to store aviation and/or diesel fuel. Use of the tanks was discontinued in 1972, and the tanks and their associated piping and concrete sub-bases were removed in 1977.

Groundwater contamination was detected in 1986, when routine sampling revealed the presence of benzene (a petroleum-related contaminant) in the water supply well in the basement of the ski lodge and then in a second well installed slightly uphill of the lodge. In 1988, benzene was detected in a third water supply well, also installed in 1986. Subsequent sampling in 1988, 1989, and 1993 has confirmed the presence of petroleum-related contaminants in the groundwater near the ski lodge. In 1987, all three of the water supply wells at the site were removed from service, and since then water from the main base wells has been trucked to the site and stored in an underground tank adjacent to the lodge to meet all site water needs.

The contamination in the groundwater is believed to be from leaked aviation or diesel fuel from the storage tanks. The petroleum-related contaminants moved through the soils and weathered bedrock at the top of the ridge into the highly fractured bedrock below; once in the upper portion of the bedrock, the contaminants are thought to have continued to move downward through the bedrock along fractures until they reached the groundwater. The contamination appears to be relatively isolated within the bedrock.

2.1.2 Previous Investigations

OU6 has been evaluated under the U.S. Air Force Installation Restoration Program (IRP) and the CERCLA remedial investigation/feasibility study (RI/FS) process. The studies listed below document preliminary investigations of OU6:

- 1982 IRP Phase I Records Search (CH2M Hill 1982)
- 1988 IRP RI/FS Stage 3, Volume II (HLA 1989)
- 1989 IRP RI/FS, Stage 4, Volumes I through V (HLA 1990)
- 1989 IRP RI/FS, Stage 4, Volumes VII through XVIII (HLA 1991)

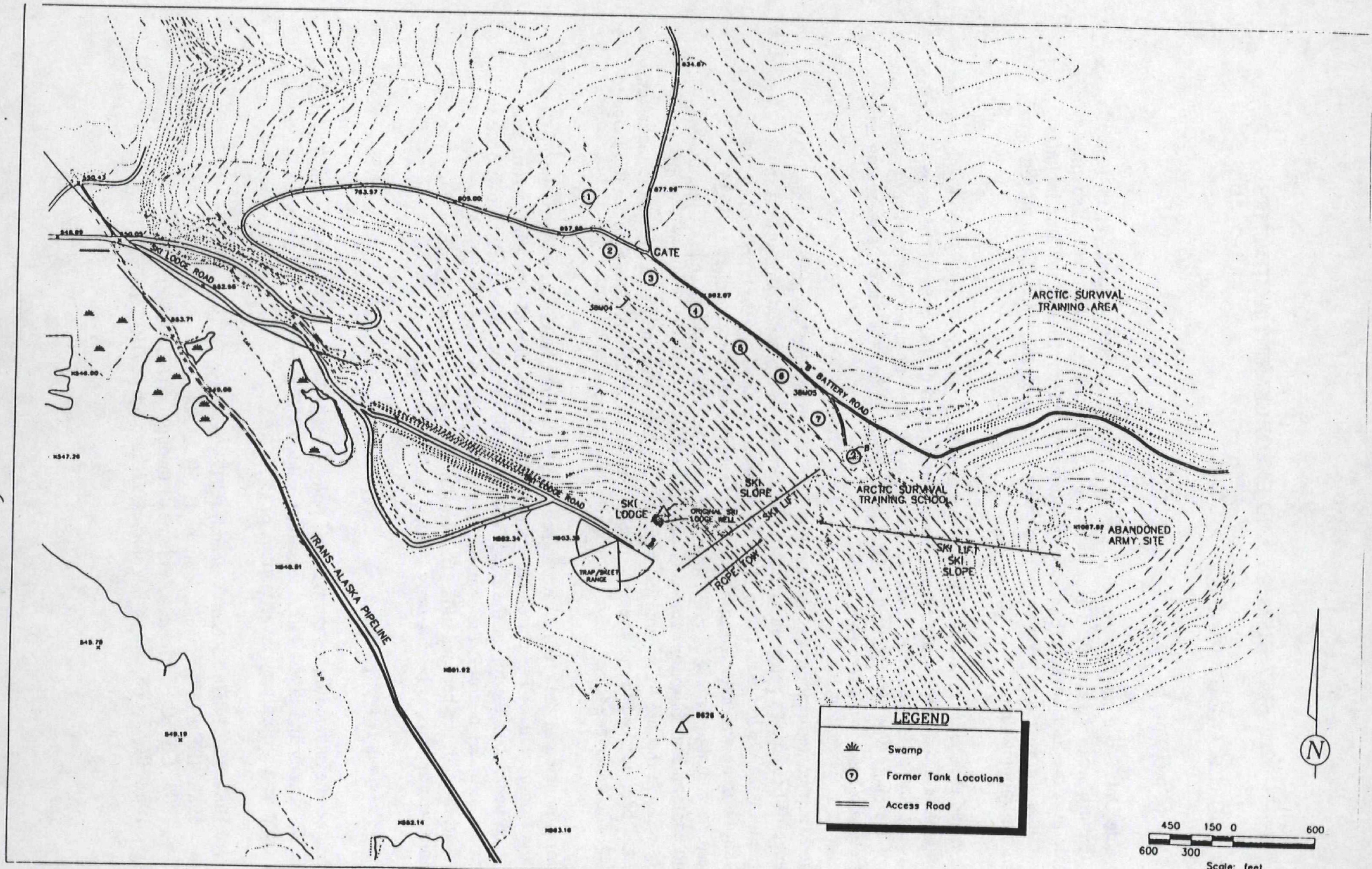

Figure 3. Ski hill with locations of former fuel storage tanks (OU6), Eielson AFB, Alaska.

Drawn:	Date:
Reviewed:	Date:
Rev.1:	Date:
Final:	Date:

The results of these studies are described in Chapter 5, Summary of Site Characteristics.

1982 IRP Phase I Records Search The literature search for possible sources of contamination at Eielson AFB (CH2M Hill 1982) did not uncover any evidence of releases at the OU6 site.

1988 IRP RI/FS Phase II, Stage 3 Investigation HLA (Harding Lawson Associates) was commissioned in 1988 to investigate OU6 and prepare a Phase II Step 3 report (HLA 1989). HLA conducted an initial field investigation of source area WP38 from July through November 1988. The investigation comprised a soil vapor survey; seismic and geophysical examination of the geology, hydrogeology, and possible permafrost at the site; and the drilling of soil borings and installation of vadose vapor monitoring wells and groundwater monitoring wells. Field tasks included surface reconnaissance, surface geophysics, a soil vapor survey, soil borings, borehole geophysical logging, monitoring well installation, soil and groundwater sampling, aquifer testing, and water-level survey.

The investigations were carried out along the ridge line, on the ski slope east of the tank storage area, in areas along the utility access road west of the tank storage area, and along the road from the main base to the ski lodge. The five soil borings drilled at the site ranged in depth from 76 to 325 ft. Soil borings were drilled downslope of tank locations, at mid-slope near the ski lodge, along the base of the hill, and out into the lowlands. Several borings were converted to monitoring wells and designated 38M01 through 38M05.

The soil vapor survey was performed in the former POL storage tank area and other accessible areas around the site; the geophysical survey was performed to assess the presence of permafrost, investigate depth to groundwater, and aid in the location of monitoring wells. A slug test was conducted in monitoring well 38M03 and a groundwater sample from well 38M01 was analyzed to determine the hydrocarbon fingerprint.

A photoionization detector (PID) OVM (organic vapor monitor) was used to screen the soil boring samples for volatile organic compounds, and the samples with the highest reading from each borehole were analyzed in a field laboratory for selected organic compounds and submitted to a laboratory to be analyzed for petroleum product indicator chemicals selected on the basis of their mobility, persistence, and toxicity: benzene, toluene, ethylbenzene, and xylenes (BTEX) and total petroleum hydrocarbons (TPH). Indicator chemicals selected for groundwater analysis were BTEX and chlorobenzene, bis(2-ethylhexyl)-phthalate, and 2-methylnaphthalene.

1989 IRP RI/FS Phase II, Stage 4 Investigation HLA conducted Phase II, Stage 4 of the IRP field investigation from August through November 1989 (HLA 1990, 1991). The investigation focused on obtaining additional information on the extent of purgeable aromatics in the groundwater southwest of the ski lodge and assessment of the fuel-related compounds beneath the former tank sub-bases. Activities included a seismic refraction survey, soil borings, installation of groundwater monitoring wells, collection of groundwater samples, and measurement of groundwater levels.

The seismic refraction survey was conducted in the vicinity of the former fuel storage tanks and ski lodge to define the stratigraphic profile, determine the presence of permafrost, and aid in positioning additional soil borings and monitoring wells. Twenty-four soil borings, ranging in depth from 12 to 47.5 ft, were drilled on the ski hill near the tank sub-bases (38SB01 through 38SB16; 38M08 through 38M15). Soil borings 38M08 through 38M15 were converted to vapor monitoring wells. Two borings (38M06 and 38M07) were drilled southwest of the ski lodge in the lowlands, to depths of 158 and 130 ft, respectively, and converted to groundwater monitoring wells.

2.2 ENFORCEMENT ACTIVITIES

Eielson AFB was listed on the National Priorities List (NPL) (54 Fed. Reg. 48184) on 21 November 1989 by the U.S. Environmental Protection Agency (EPA). This listing designated the facility as a federal Superfund site subject to the remedial response requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). In accordance with EPA policy, Eielson AFB was placed on the NPL on the basis of its Hazard Ranking System score. Sixty-four potential source areas at Eielson AFB were divided into six operable units (OUs) and three source evaluation report (SER) groups, on the basis of commonality of characteristics and of contaminants. Two more potential source areas were added to the SER groups in 1992, bringing the total to 66.

As a result of Eielson's listing on the NPL, Eielson, EPA, and the State of Alaska Department of Environmental Conservation (ADEC) entered into a Federal Facility Agreement pursuant to CERCLA in October 1990. The FFA established a procedural framework for agency coordination and a schedule for all CERCLA activities conducted at the base. This final action, the Record of Decision for Operable Unit 6, is undertaken in accordance with the FFA.

Eielson AFB is also party, with EPA, to a RCRA Federal Facility Compliance Agreement, signed on 15 June 1988, which required Eielson to pursue RCRA closure at site-specific hazardous waste management areas. These activities are ongoing at some sites at the base, but there are no such sites at OU6.

3. HIGHLIGHTS OF COMMUNITY PARTICIPATION

3.1 COMMUNITY RELATIONS PRIOR TO THE FINAL ACTION

In accordance with Sections 113(K)(2)(b)(i-v) and 117 of CERCLA, community interviews were conducted in the early 1990s with local officials, community residents, and public interest groups to solicit concerns and information needs and to learn how and when citizens would like to be involved in the CERCLA process at Eielson AFB. The information gathered during community interviews and other relevant information provided the basis for the development of the Community Relations Plan (CRP) (USAF 1991).

The community relations staff first interviewed 40 local residents and community leaders to develop plans to keep residents informed about the cleanup activity at Eielson AFB. Follow-up interviews and questionnaires of more than 100 residents helped revise the Community Relations Plan. An environmental cleanup newsletter was created and mailed to anyone who wished to be on the mailing list, and fact sheets were prepared on various topics related to cleanup operations. Several times a year, articles describing significant cleanup events have been released to the base newspaper, *The Goldpanner*, and to the *Fairbanks Daily News-Miner* and the *North Pole Independent*. These efforts were designed to involve the Community in the cleanup process through comments they might make on the information that was furnished.

3.2 COMMUNITY RELATIONS TO SUPPORT SELECTION OF A REMEDY

A Technical Review Committee (TRC) was established in 1992 that included three representatives of the community (selected by local officials and the Chancellor of the University of Alaska, Fairbanks), industry representatives, and environmental agency representatives. In November 1993 a local environmental interest group was invited to participate. A preliminary version of the Proposed Plan for the remediation of OU6 was presented to the TRC on 27 January 1994. At that meeting, representatives from the U.S. Air Force, ADEC, and EPA responded to questions from an audience representing the University of Alaska, the city of North Pole, and various state and federal agencies.

The RI/FS documents (USAF 1994a, b, and c) and the Proposed Plan (USAF 1994d) for Operable Unit 6 of Eielson AFB were released to the public in March 1994. The documents were made available in both the Administrative Record office at the base and in an information repository maintained at the Elmer E. Rasmussen Library at the University of Alaska, Fairbanks.

The Proposed Plan for OU6 was advertised twice in two local newspapers, and more than 3,500 copies were added as an insert in the base newspaper and delivered to every home in the base housing area. A news release announcing the Proposed Plan and a public meeting on 12 April was sent to all local news media (radio, television, newspapers), and the story ran on the front page of the base newspaper. The meeting was advertised on the base access cable channel and in the base information bulletin, and on at least one local area radio station as well. The First Sergeants Group (the senior enlisted leadership for each unit on the base) was briefed on the plan and public meeting, to encourage their people to attend. Copies of the plan were delivered to various information repositories and to the North Pole City Hall.

A public comment period and public meeting were advertised on 18 March in the *Goldpanner* base newspaper. A 9-inch display ad that highlighted the cleanup efforts was placed in the *North Pole Independent* on 18 March and in the *Fairbanks Daily News-Miner* on 20 and 21 March.

The public meeting for the Proposed Plan was held on 12 April 1994. At that meeting, representatives from the Air Force, ADEC, and EPA answered questions about problems at the sites and the remedial alternatives under consideration. About 10 members of the public attended.

The public comment period on the Proposed Plan ran from 22 March through 22 April 1994. Comments received during that period, and the Air Force responses, are summarized in the Responsiveness Summary of this ROD.

This ROD and the attached Responsiveness Summary will be available in the Administrative Record office and at the information repository listed below:

Elmer E. Rasmussen Library
Arctic and Polar Regions Archives Section
University of Alaska, Fairbanks
Fairbanks, AK 99775
907/474-6594

4. SCOPE AND ROLE OF OPERABLE UNIT 6

The Federal Facility Agreement organized the CERCLA study sites at Eielson AFB into six OUs, on the basis of similar source characteristics or contaminants. Operable Unit 6, the subject of this ROD, addresses the problem of groundwater at the ski hill source area that has been contaminated by leaks and spills from the fuel tanks and piping formerly located at the top of the ridge.

The ski hill area is used primarily for recreational and military training purposes. Groundwater sampled in wells downgradient of the hilltop area has been found to contain petroleum hydrocarbons, but the groundwater at OU6 is not extracted or used for any purpose at present. The potential contribution of the bedrock aquifer to groundwater in the vicinity, and the amount and direction of flow in the bedrock aquifer are difficult to determine.

Five other operable units are under consideration for remedial action at Eielson AFB:

- OU1 Petroleum, Oil, and Lubricant (POL) Contamination
- OU2 POL Contamination
- OU3 Solvent Contamination
- OU4 Land Disposal of Fuel Tank Sludge, Drums, and Asphalt
- OU5 Land Fills

An interim action at OU1B was initiated in June 1992 to address "floating product." RODs are in progress for OU1 and OU2. RI/FS reports are in progress for OU3, OU4, and OU5.

Thirty-one source areas not included in any OU are being evaluated through the Source Evaluation process. Of these, 21 are proposed for no further action, and 10 are still undergoing evaluation.

A "sitewide" RI/FS and ROD will also be completed to address cumulative risks (including ecological risks) for all source areas and to allow for monitoring of areas that have been investigated and recommended for no further action.

5. SUMMARY OF SITE CHARACTERISTICS

The area of OU6 is a southwest-facing hillside slope that extends from the ski hill ridgetop to somewhat swampy, relatively flat lowlands. The geologic units encountered at the site include fractured bedrock, weathered bedrock, a layer of soil (loess) mantling the top of the bedrock, and, at the bottom of the hill, alluvial sediments. The layers of alluvial sediments lie unconformably on the bedrock and extend southwestward at the bottom of the hill; this alluvium is part of the Tanana River plain, which contains the major groundwater aquifer at Eielson AFB. It contains discontinuous permafrost in the area of the ski hill.

Petroleum contaminants were released from some of the eight 50,000-gallon above-ground fuel storage tanks and associated piping that were formerly located on the ridgetop along B Battery Road. Fuel contamination has since been found in the soil at the top of the ridge and in the groundwater in the bedrock near the base of the slope. Studies of the ski hill have investigated the distribution of the fuel contamination in the environmental media. Samples of soil, weathered bedrock, surface sediment, and groundwater have been collected and analyzed.

The data from studies prior to 1993 were not validated, so those data were reviewed and analyzed and used to select locations for the 1993 RI/FS field work, the analytical results of which are compiled in the RI for OU6 (USAF 1994a).

5.1 GEOLOGY AND HYDROGEOLOGY

The geology of the site was investigated by logging borings drilled in soil and bedrock, by surface geology investigations, and by interpretation of geophysical survey results. Numerous soil borings were located at the top of the ridge near the bases of the former tanks. These borings intersected a layer of soil composed mostly of loess and silty soil that is between 0 and 20 ft thick. A seismic refraction survey was completed to investigate the soil-bedrock interface in the area of the former tanks and also the distribution of the permafrost in the alluvial sediments at the bottom of the hill. The results of the geophysical survey at the top of the hill confirmed that the soil was a thin layer, and that the bedrock-soil interface surface was of low relief. The soil unit at the top of the hill is not water-bearing.

The partly exposed bedrock unit at OU6 is known regionally as the Birch Creek Schist, but locally the rock types are quartz-biotite schists, highly weathered near the surface, with graphite and quartz layers at depth. The depth to water in the bedrock varies from approximately 40 ft below the surface in the area of the ski lodge to approximately 270 ft below the surface at the top of the ridge. A total of nine groundwater monitoring wells (38M01–38M07, 38M16, 38M17) and three groundwater supply wells (SLW, 8621, and 8626) have been installed at the site with auger or air rotary drilling equipment. All but three of these wells (38M07, 38M16, 38M17) were screened in the bedrock.

Water levels were observed to rise rapidly after first water during drilling of the wells in the bedrock. This suggests that confined conditions may exist in the fractured bedrock aquifer. No geologic evidence of a confining layer was observed in the logging of the borings, and permafrost is not generally present in bedrock in an area where permafrost is discontinuous in the alluvium. The interpretation of the bedrock aquifer as either confined or unconfined is uncertain. One slug test was conducted on well 38MO3; the results indicated that the aquifer has a hydraulic conductivity of approximately 1.2 ft/day in the area of the well. Measurements made in July 1993 of the potentiometric surface in the wells at OU6 indicate that the hydraulic gradient in the schist is toward the south-southwest, at values between 0.021 and 0.25. Figure 4 shows a hydrogeologic cross-section of the ridge through tank sub-base 8 and the ski lodge.

The hydrologic information about the bedrock aquifer is subject to the uncertainties common to most bedrock aquifer systems. It is possible that the flow of liquids in the unsaturated portion and also in the saturated portion of the bedrock is controlled by a relatively small number of hydrologically significant heterogeneities, i.e., fractures that are much more permeable than the bedrock blocks between these fractures. The location, orientation, and connectedness of the significant fractures cannot be determined using conventional field methods or a reasonable number of investigative or monitoring points. The flow of the fuel contaminants in the unsaturated zone, of the contaminated groundwater in the saturated zone, and of the uncontaminated water in the saturated zone are all subject to considerable uncertainty as to the direction and magnitude of downgradient flow. The locations and magnitudes of the maximum concentrations of the contaminants are also subject to uncertainties.

The alluvial sediments at the base of the ski hill area are part of an extensive sedimentary unit that makes up the level portion of the Tanana valley. The sediments are primarily sands and gravels, and they are 200–300 ft thick at Eielson AFB. The sediments lie unconformably on the bedrock. The sediments are saturated below approximately 8 ft depth; the alluvial aquifer is highly productive and an important water source in the Tanana valley.

A total of seven water wells (8626, 38M02, 38M03, 38M06, 38M07, 38M16, 38M17) were drilled into or through the alluvial aquifer at OU6, but only three of these (38M07, 38M16, and 38M17) were screened in the alluvium itself. The alluvial aquifer may be locally confined by permafrost, as evidenced by frozen sediments encountered during drilling and an immediate and considerable rise in water levels in the wells after first water was encountered. The results of the geophysical survey in the alluvium indicated that the permafrost was too discontinuous to permit interpretation of the geophysical data.

The direction of groundwater flow in the alluvial aquifer is generally to the north-northwest (the direction of the Tanana River) in the developed portion of the base, where elevation control is good. In that location the aquifer is influenced locally by Garrison Slough, by Hardfill Lake, probably by French Creek, and by pumping of the base water supply wells.

Groundwater, the only source of potable water at Eielson AFB, is supplied by three large-capacity wells located near the power plant at the center of the base, approximately 3 miles from OU6 (see Figure 2). The supply wells are of 1,000–2,000 gallon per minute capacity. The base water supply wells are completed at depths averaging approximately 100 ft. At present (1994), water from those wells furnishes the domestic water supply at the OU6 site.

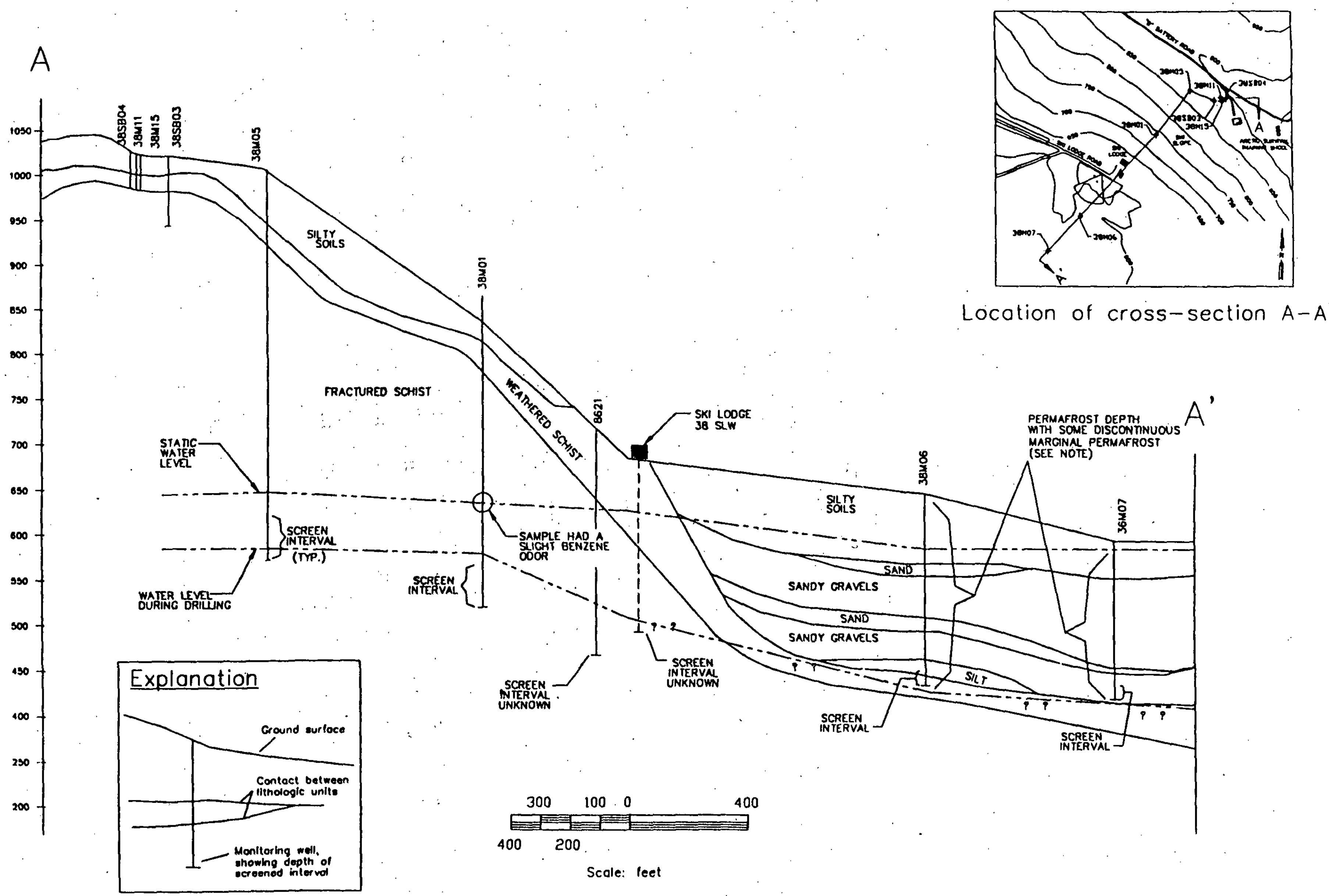

Figure 4. Hydrogeologic cross-section, OU6, Eielson Air Force Base, Alaska.

Drawn:	Date:
Reviewed:	Date:
Rev.1:	Date:
Final:	Date:

In addition there are seven wells designated to provide water to fight fires on the base, and these are designed for emergency use only. They are plumbed to the water supply system.

5.2 NATURE AND EXTENT OF CONTAMINATION

The environmental media sampled in 1993 for the RI were soil, sediment, and groundwater. Soil and groundwater were also sampled in the previous investigations, and groundwater was routinely sampled in the water supply wells at the site when they were in use. The contaminants investigated in 1993 were the fuel compounds benzene, toluene, ethylbenzene, and xylene (BTEX); total petroleum hydrocarbons (TPH); total diesel hydrocarbons (DRO); total gasoline hydrocarbons (GRO); and the metals cadmium, chromium, and lead. Other metals were found in the soil at concentrations typical of those occurring naturally at the base, and they are not considered to be present as contaminants. The results of the 1993 and earlier sampling effort are summarized below.

Soil

Soil samples were collected from soil borings (38SB01–38SB18, Figure 5) and in the borings for groundwater (38M01–38M07) and vadose-zone monitoring wells (38M08–38M17). The borings for wells M01–M07 (see Figure 5), carried out in 1988, were drilled just downslope of the tank sub-bases (M04, M05), at midslope above the ski lodge (M01), and at the base of the hill (M02, M03). Wells 38M06 and 38M07 were drilled in the lowland alluvium in the assumed downgradient direction from the ski lodge well. Soil samples were taken from these wells at the following depths (generally the bottom of the boring):

	38M01	38M02	38M03	38M03	38M04	38M05	38M06	38M07
Depth (ft)	171	43	47	72	50	114	--	--
TPH (mg/kg)	27	ND	12.8	ND	13.6	ND		

The samples were analyzed only for TPH. The samples from M06 or M07, the wells in the alluvial plain, were not analyzed offsite.

The concentrations of organic analytes detected in the remaining samples are shown in Table 1. (In 1993 two groundwater monitoring wells were drilled at the foot of the hill, 38M16 to the west, below tank sub-base 1, and M17 on a possible pathway below sub-bases 1 and 2.) Borings were concentrated at two locations: near the tank sub-bases and, to a lesser extent, downslope along potential migration pathways, (e.g., north of sub-base 1, southwest of sub-bases 3 and 5). Soil samples were collected at several depths from each boring.

Fuel compounds were detected in the soils near the tank sub-bases. The highest concentrations of Total Petroleum Hydrocarbons were found in 38M10, 38M13, and 38M14, below tank sub-bases 1 and 2 (see Figure 5). The highest concentrations of benzene, toluene, ethylbenzene, and xylenes were found in wells 38M09, 38M10, and 38M11. The highest level of contamination in the areas sampled to date is found near tank sub-base 1, at the

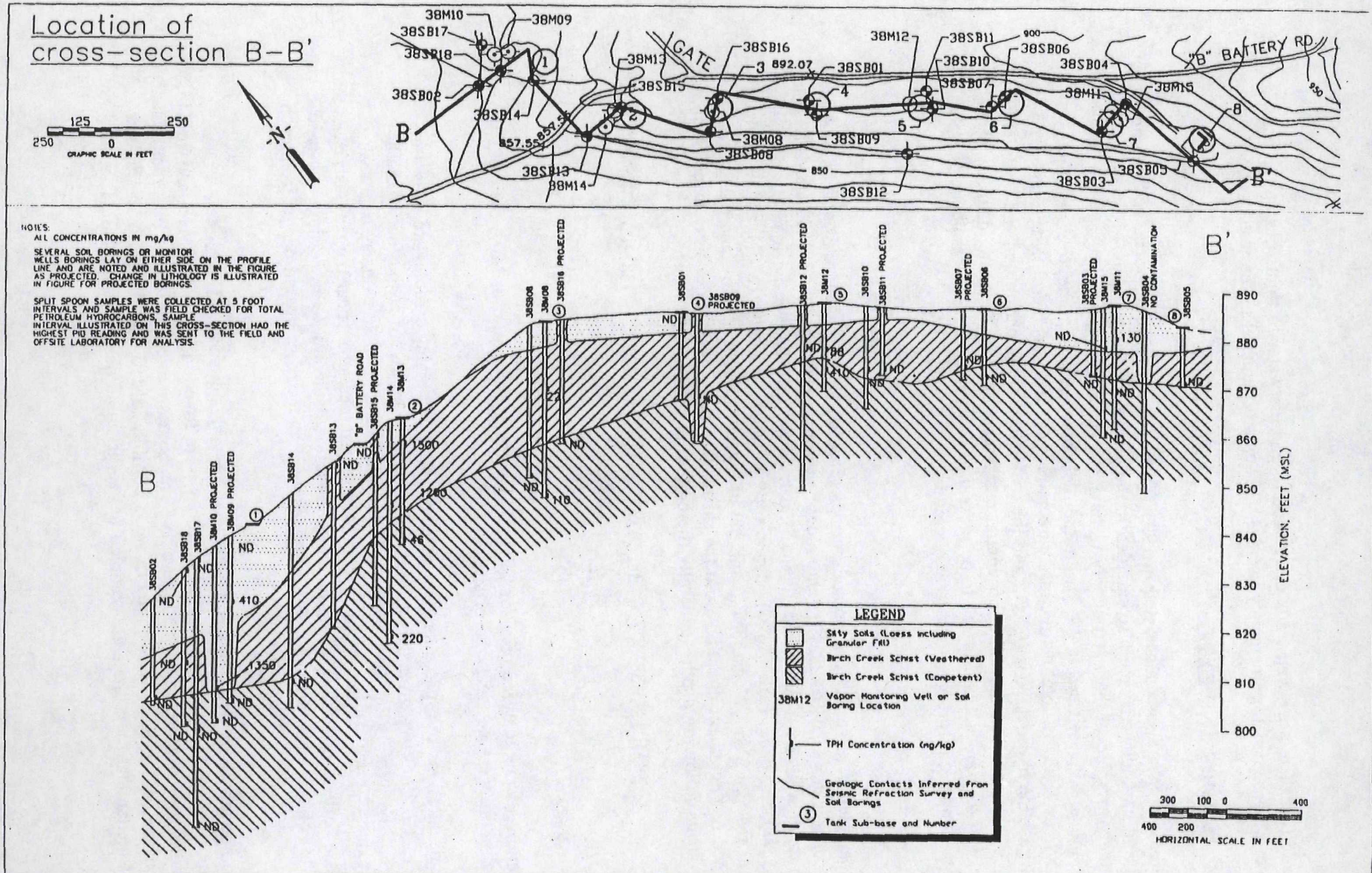

Figure 5. Vertical extent of petroleum constituents, OU6, Eielson Air Force Base, Alaska

Drawn:	Date:
Reviewed:	Date:
Rev.1:	Date:
Final:	Date:

TABLE 1 CONCENTRATIONS OF ORGANIC ANALYTES IN SOIL SAMPLES, OU6, EIELSON AFB, 1988–1993[a]

Well Boring	Sample Depth (ft)	Concentration (mg/kg)						
		Benzene	Ethylbenzene	Toluene	Xylenes	DRO	GRO	TPH
38M08	10.0–11.5	ND	1.7	1.6	13.5	--	--	21.9
	30.0–30.7	ND	ND	ND	ND	--	--	ND
38M09	15.0–17.0	35.6	53	140	400	--	--	408
	15.0–17.0	NS	NS	NS	NS	--	--	144
	45.0–47.0	ND	ND	ND	ND	--	--	ND
38M10	30.031.5	27.5	91	180	752	--	--	1,330
	40.0–41.5	ND	ND	ND	ND	--	--	ND
38M11	5.0–6.5	25.2	59	620	440	--	--	133
	25.0–26.4	ND	ND	ND	ND	--	--	ND
38M12	100–11.0	ND	ND	ND	ND	--	--	875
	15.0–15.6	ND	ND	ND	18.6	--	--	406
38M13	5.0–6.5	ND	ND	3.5	16.1	--	--	1,470
	25.0–26.0	ND	ND	ND	14.3	--	--	45.6
38M14	25.0–25.5	ND	5.6	9.7	31.5	--	--	1240
	45.0–46.5	ND	ND	ND	8.68	--	--	220
38M15	10.0–11.5	ND	ND	ND	ND	--	--	ND
	25.0–27.0	ND	ND	ND	ND	--	--	ND
	25.0–27.0	ND	ND	ND	ND	--	--	ND
38M16	0.0–1.5	NS	NS	NS	NS	31	--	35
	10.0–11.5	ND	ND	ND	ND	35	ND	57
	10.0–11.5	ND	ND	0.0008	0.0011	12	ND	14
	14.5–16.0	ND	ND	0.0006	ND	14	ND	13

a. 38M08–38M17 - October 1989; 38SB17, 38SB18 - July 1993.

Note: DRO - Diesel-range organics; GRO - gasoline-range organics; TPH - total petroleum hydrocarbons.
ND - Below method or sample detection limit; NS - Sample not analyzed for parameter.

TABLE 1 (continued)

Well Boring	Sample Depth (ft)	Concentration (mg/kg) Benzene	Ethylbenzene	Toluene	Xylenes	DRO	GRO	TPH
38M17	0.0–1.5	ND	ND	ND	ND	13	ND	8.8
	12.5–14.0	ND	ND	ND	ND	ND	ND	ND
	12.5–14.0	ND	ND	ND	ND	16	ND	6.7
	17.5–19.0	ND	ND	ND	0.0012	26	ND	6.4
38SB17	0.0–1.5	ND	ND	0.0008	0.0011	ND	ND	ND
	15.0–16.5	0.0006	ND	0.0011	0.0025	ND	1.4	ND
	15.0–16.5	0.0013	ND	0.0010	0.10	6.9	1.8	ND
	50.0–51.5	ND	ND	ND	0.0013	ND	ND	ND
	60.0–61.5	ND	ND	ND	ND	ND	ND	ND
38SB18	0.0–1.5	ND	ND	ND	ND	23	ND	ND
	0.0–1.5	ND	ND	ND	ND	12	ND	6.4
	16.0–17.5	ND	ND	ND	ND	ND	ND	NS
	30.0–31.5	ND	ND	ND	ND	11	ND	ND

northwest end of the line of tank sub-bases, and near sub-base 7, near the southeast end of the line of sub-bases. The data suggest that the petroleum contaminants migrated through the soil in a dominantly vertical direction.

Metal concentrations in the soil samples were in the ranges of background concentrations for the metals investigated. For example, of 11 lead samples, 10 were in the range reported for background levels in fluvial soils at Eielson AFB, which averaged 10 mg/kg, and the 11th, at 35 mg/kg, was found in competent schist. The same was true for chromium: of 11 samples, the only one outside of the background range (average 26 mg/kg) was found in competent schist in 38SB18.

Sediments

Six sediment samples were collected from the materials underlying standing water in the wetlands at the foot of the ridge (Figure 6). The sampling points were located near "inflow" points, where it was estimated that subsurface water from the ridge might be rising to the surface, and where sediments were thick enough to permit collection of a sample.

The results of the sediment sample analyses are shown in Table 2. The fuel constituents tested for were detected in varying numbers of the samples, at concentrations below the level of regulatory concern. The various samples contained low concentrations of benzene, toluene, ethylbenzene, xylenes, diesel-range hydrocarbons, gasoline-range hydrocarbons, and TPH. For example, benzene was found in two of the six samples, at concentrations of 0.01 and 0.013 mg/kg; TPH was found in all six, at 13–120 mg/kg. Because the samples were taken near the road to the ski lodge, a local vehicular source cannot be excluded, and the ultimate source of the constituents found in the sediments cannot be identified with certainty.

Lead was found in all six samples, at 6.4–16 mg/kg; chromium, at 22–32 mg/kg. Both ranges are within the background level ranges reported for Eielson AFB.

Groundwater

Groundwater samples were collected from the water supply wells (see Figure 6) and the monitoring wells and analyzed for organic and inorganic constituents. Four of the wells are periodically or permanently inaccessible, because of ice or equipment in the well casing (8621, 38M07, and 38M08) or damage to the well head (8626).

Table 3 summarizes the organic contaminants detected in groundwater samples from the wells through 1993. Benzene was found at levels greater than 5 µg/L in wells SLW, 8626, and 38M01. It was detected at concentrations less than 5 µg/L in wells 38M04 and 38M05. The greatest number and highest levels of all contaminants were found in samples from 38M01. The Benzene contamination in 38M01 decreased and then increased in the period 1988–1993. However, the concentrations of other BTEX components have declined. This may be attributed to natural degradation and attenuation processes in which benzene is attenuated more slowly than the other BTEX components. The benzene concentration in 38M01 varied from 868 µg/L in 1988 and 510 µg/L in 11989 to 910 µg/L in 1993.

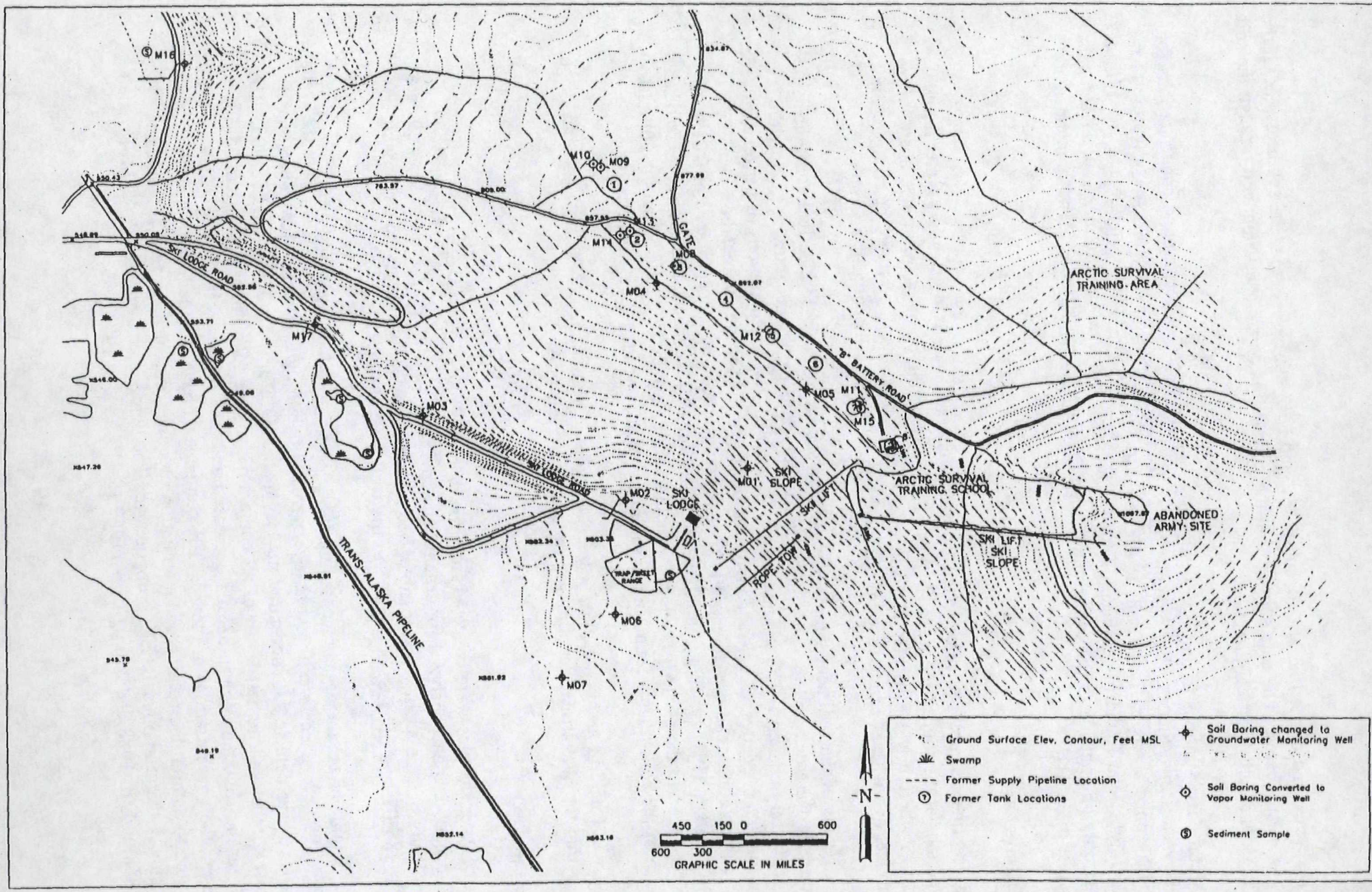

Figure 6. Sampling locations, OU6, Eielson Air Force Base, Alaska.

Drawn:	Date:
Reviewed:	Date:
Rev.1:	Date:
Final:	Date:

TABLE 2 CONCENTRATIONS OF ORGANIC ANALYTES IN SEDIMENT SAMPLES, OU6, EIELSON AFB, JULY 1993

	Concentration (mg/kg)						
Sample Number	Benzene	Ethylbenzene	Toluene	Xylenes	DRO	GRO	TPH
38SD01	ND	ND	0.0013	0.0020	27	0.29	78
38SD02	0.013	0.013	0.069	0.076	ND	0.66	18
38SD03	ND	ND	0.0007	ND	ND	ND	13
38SD03-01*	ND	ND	ND	ND	ND	ND	23
38SD04	0.0010	0.0008	0.0045	0.0046	28	ND	110
38SD05	ND	ND	0.0015	ND	28	ND	120
38SD06	ND	ND	ND	ND	11	ND	40

Note: DRO - Diesel-range organics; GRO - gasoline-range organics; TPH - total petroleum hydrocarbons.
ND - Below method or sample detection limit.

* Duplicate sample.

TABLE 3 CONCENTRATIONS OF ORGANIC ANALYTES IN GROUNDWATER, OU6, EIELSON AFB, 1988–1993

		Concentrations (µg/L)				
Well	Sampling Session[a]	Benzene	Toluene	Ethyl-benzene	Xylenes	TPH
38M01	1988	868	1,400	318	1,890	10,700
	1989	510	96.6	21.3	230	
	1992	590.0	5.9	4.4	5.0	
	1993	910	27	ND	50	1,500
38M02	1988	<0.15	0.84	<0.46	<0.85	500
	1989	<0.20	<0.30	<0.50	<0.40	
	1992	<2.0	<2.0	<2.0	<5.0	
	1993	ND	ND	ND	ND	100
38M03	1988	<0.15	<0.25	<0.46	<0.85	<100
	1989	<0.20	<0.30	ND	<0.40	
	1992	<2.0	<2.0	ND	<5.0	
	1993	ND	ND	ND	ND	100
38M04	1988	3.77	2.15	<0.46	<0.85	<100
	1989	<0.20	2.02	<0.50	<0.40	
	1992	<2.0	<2.0	<2.0	<5.0	
	1993	ND	ND	ND	ND	500
38M05	1988	0.19	0.43	0.82	<0.85	400
	1989	0.43	1.10	<0.50	<0.40	
	1992	<2.0	<2.0	<2.0	<5.0	
	1993	0.54	ND	ND	ND	1,500
38M06	1988	--	--	--	--	--
	1989	<0.20	<0.30	<0.50	<0.40	
	1992	--	--	--	--	

a. 1988: IRP Phase II, Stage 3; 1989: IRP Phase II, Stage 4; 1992; 1993: RI/FS.

TABLE 3 (continued)

Well	Sampling Session[a]	Concentrations (µg/L) Benzene	Toluene	Ethyl-benzene	Xylenes	TPH
38M07	1988	--	--	--	--	--
	1989	<0.20	14.7	<0.50	<0.40	
	1992	--	--	--	--	
	1993	ND	0.0012	ND	ND	1,130
8626	1988	148	<0.25	<0.46	<0.85	ND
	1989	18.8	3.00	<0.50	<0.40	
	1992	--	--	--	--	
38M16	1993	ND	ND	ND	0.77	100
38M17	1993	ND	ND	ND	ND	100
38SLW	1993	140	ND	ND	ND	100

Benzene was first detected in the ski lodge well in a water sample collected on 13 August 1986, at a concentration of 145 µg/L. The well was resampled on 30 August, and the presence of benzene was confirmed, at 115 µg/L. The well was sampled quarterly from July 1987 to October 1990; concentrations of benzene ranged from below the detection limit to 33 µg/L. A carbon filter was installed at the wellhead at an unknown date: the December 1988 value was annotated "no treatment" and had a concentration of 20 µg/L. It is not known if samples collected between July 1987 and October 1990 were collected upstream or downstream of the carbon filter. The next sample, collected in 1993, contained benzene at a concentration of 140 µg/L.

No fuel contaminants other than TPH (Method 418.1) have been detected in samples from wells 38M03, 38M06, and 38M17.

6. SUMMARY OF SITE RISKS

This chapter summarizes the Baseline Risk Assessment (RA) for OU6 (USAF 1994b), which forms the basis for taking action and indicates the exposure pathways that need to be addressed by the remedial action. It indicates what risks could exist if no action were taken at the site. Environmental risks may be categorized as ecological risks and human health risks.

6.1 HUMAN HEALTH RISKS

A human health risk assessment begins with identification of COC (chemicals of concern) at the site and the exposure pathways for those chemicals to receptors (human beings). To estimate the risk to receptors, measures of the toxicity of the COC as delivered by the particular exposure pathways are combined mathematically with conservative estimates of the concentrations of COC as delivered and the duration of exposure. The MEPAS (Multimedia Environmental Pollutant Assessment System) integrative model was used. Its main components are an exposure assessment (Section 6.1.2) and a toxicity assessment (6.1.3).

6.1.1 Identification of Contaminants of Concern

The contaminants of concern for the OU6 site were identified using the screening method suggested in the supplemental guidance for Superfund Risk Assessments in EPA Region 10 (EPA 1991). This method, called the "risk-based screening approach," compares the highest concentration of each chemical detected at a site to a risk-based screening concentration. Screening concentrations were chosen, using a residential exposure scenario, for the ingestion of soils and sediments and for the ingestion of water and inhalation of its vapors during showering. Possible COC were listed, on the basis of the results from the analysis of about 250 soil, water, soil vapor, air, and groundwater samples collected at the site in the period 1986–1993, and the highest 1993 concentration for each contaminant for each medium sampled was compared to concentrations estimated to pose a risk to receptors.

A chemical was eliminated if the maximum concentration was less than the cancer risk concentration of 1E–6 (one in one million) in water and less than 1E–7 in soil (the threshold was lowered 10-fold to take into account the multiple exposure pathways for soil-borne contaminants). For non-cancer risks, the corresponding values for both soil and water were a total H/Q ratio (i.e., the sum of all ratios of the concentration in the medium to the highest concentration estimated not to cause a noticeable effect with chronic exposure, summed across all exposure paths for the chemical) of 0.1. Chemicals were also eliminated if their presence could not be attributed to the source of contamination.

Table 4 presents the resulting list of chemicals of concern for the OU6 site and the concentrations of those chemicals that served as input to the risk assessment calculations. The analytical data used, collected during the 1993 field season, are listed in Appendix E of the RI (USAF 1994a). The concentration listed for each chemical of concern is either the 95 percent upper confidence limit on the mean concentration for all samples (95 percent UCL) or the highest measured value, if it is less than the 95 percent UCL or if the data did

TABLE 4 CONCENTRATIONS[a] OF CHEMICALS OF CONCERN USED FOR RISK ASSESSMENT AT OU6, EIELSON AFB

Chemical of Concern	Surface Soil, Sediment (mg/kg)		Groundwater (µg/L)	
	Highest	95% UCL	Highest	95% UCL
Benzene	0.0013	0.0004	910	260
Ethylbenzene	0.0013	0.0002	0	ND
Toluene	0.0069	0.0020	27	8
Xylenes (total)	0.0076	0.0009	50	15
Total Petroleum Hydrocarbons	120	70	1,500	970
Diesel Hydrocarbons	86	57	1,350	890
Gasoline Hydrocarbons	0.66	0.24	3,800	1,100

a. Highest concentration is highest single concentration detected in sampling at OU6 between 1988 and 1993 for soils; highest in 1993 for groundwater. 95% UCL concentration is 95th percentile value of all measured samples; values below the detection limit were set at the detection limit.

Note: 95% UCL was used for RME (Reasonable Maximum Exposure) concentration in risk assessment calculations unless the distribution of values was not normal or the highest value measured was less than the 95% UCL.

not exhibit a normal distribution. All water analyses were used, along with all soil and sediment analyses that met or exceeded EPA Level III.

There are no EPA toxicity data for two of the principal contaminants at site OU6: TPH and lead. Although lead concentrations were generally at soil background levels for Eielson AFB, the presence of a higher concentration in the schist of the ski hill led to its inclusion in the risk assessment. Accordingly, these compounds were not included in the primary risk calculations. An analysis for lead risk to children was calculated separately, and EPA Region 10 guidance (EPA 1991) was used for TPH in groundwater.

6.1.2 Exposure Assessment

An exposure pathway consists of a source and release mechanism, an environmental transport medium, a point of exposure, and a human receptor and mechanism of exposure. The OU6 site is in a relatively undeveloped area and is used at present for recreation and for the Arctic Survival Training School, and thus exposure to chemicals is temporary and intermittent. Water used on the site comes from uncontaminated wells elsewhere on the base.

The points of exposure for soil are sediment accumulations at the foot of the slope and surface soil near the former tank sites. Water, assuming the use of groundwater from the site, is from wells near the present monitoring wells. The 95 percent UCL of the chemicals of concern for these source locations were entered into the risk assessment models.

The exposure assessment was made for four land-use scenarios. In two of them, groundwater from the site itself is used: "future use," by residents of housing at the site and by military personnel engaged in industrial activity. These scenarios assume ingestion, inhalation of vapors (e.g., in showers), and dermal contact with contaminated water; they also involve incidental ingestion of and dermal contact with surface soil from the site. A third scenario is "current" industrial use of the site by military personnel, with soil but not groundwater exposure, and the fourth is recreational use (which was defined as 65 days per year of camping at the site), also involving soil but not water exposure. All of these scenarios are hypothetical, to a greater or lesser degree, and are intended to define conservative (high) exposure to site contaminants. Both of the industrial scenarios and the recreational scenario assume use of the site by adults; the residential scenario, use by adults and children. Table 5 lists the exposure pathways that were considered complete for each land-use scenario. The point exposure concentrations for the contaminants are included in Table 4.

The degree of exposure depends on the duration and frequency of contact, the size and age of the receptor, and the conditions of exposure. The exposure factors used for the four land-use scenarios generally follow EPA Region 10 guidance (EPA 1991). Exposure factors for both "Average Exposure" and the more conservative "Reasonable Maximum Exposure" cases were used. The factors used are listed in Tables B.1 through B.13 in Appendix B of the RA (USAF 1994b). There was some divergence from the standard default exposure factors: the exposure duration for soils and sediments was adjusted to take into account the long periods of snow cover in the subarctic climate at Eielson AFB. The values used (130 days per year for industrial use and 180 days for residential use) were based on the number of days in

TABLE 5 EXPOSURE PATHWAYS FOR CHEMICALS OF CONCERN AT OU6, EIELSON AFB, ALASKA

Scenario / Pathway
1. Current Camp Workers and Recreators
Ingestion of soil or sediment
Dermal contact with soil or sediment
2. Current Military Personnel
Ingestion of soil or sediment
Dermal contact with soil or sediment
3. Future Military Personnel
Ingestion of soil or sediment
Dermal contact with soil or sediment
Inhalation of VOCs released from groundwater
Dermal contact with groundwater
4. Future Residents
Ingestion of soil or sediment
Dermal contact with soil or sediment
Inhalation of VOCs released from groundwater
Ingestion of groundwater
Dermal contact with groundwater

Fairbanks without snow cover. The mean number of days without snow cover at Fairbanks is 146; 180 days is presented as a reasonable maximum value. The industrial exposure duration reflects a 5-day work week. These values were initially advanced in Appendix A of the Management Plan for Operable Units 3, 4, and 5 of Eielson AFB (Battelle 1992). The effect of adjustment is discussed in the section on uncertainties (Section 6.1.5).

The input concentrations for groundwater BTEX for future scenarios were set at the 95 percent UCL of the concentrations measured in the monitoring wells at the site.

Assumptions used in the exposure assessment modeling component of the MEPAS program include the following:

- Each component in the BTEX group can be modeled as a separate and independent constituent.

- There will not be any changes in concentrations with time. (No modeling of the effect of the passage of time on concentration was included in the risk assessment.)

6.1.3 Toxicity Assessment

The values and references for all toxicity data used in the risk assessment are given in Table 9.1 of the Risk Assessment. Tables 6 and 7 are samples of the toxicity data for the chemicals of concern. Toxicity data are expressed as slope factors (SFs) for carcinogens (Table 6) and as reference dosages (RfDs) for noncarcinogenic toxic chemicals (Table 7).

SFs have been developed for Carcinogenic Assessment Groups by EPA for use in estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals of concern. SFs, which are expressed in units of (mg/kg-day)-1, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. SFs are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied (e.g., to take into account the use of animal data to predict effects on humans).

RfDs (reference doses) have been developed by EPA for oral exposure to toxic chemicals to indicate the potential for adverse health effects from exposure to contaminants exhibiting noncarcinogenic effects. The corresponding measure for chemicals that are inhaled is the RfC (reference concentration). RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals, that will not result in appreciable adverse effects on health. Estimated intakes of chemicals of concern from environmental media (e.g., the amount ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied.

TABLE 6 REFERENCE DOSES AND CRITICAL EFFECTS OF THE CHEMICALS OF CONCERN AT OU6, EIELSON AFB, ALASKA

Chemical	Reference Dose (mg/kg-d)	Level of Confidence[a]	Critical Effect
		Organics	
Benzene	UR	--	--
Ethylbenzene	1.00–01	Low	Liver and kidney toxicity in rats
Toluene	2.00E–01	Med	Changes in liver and kidney weights in rats
Xylenes	2.00E+00	Med	Hyperactivity, decreased body weight and increased mortality in male rats
Petroleum Hydrocarbons	--	--	--
Diesel Hydrocarbons	8.00E–03*	Low	Fatty changes in the liver of mice
Gasoline Hydrocarbons	2.00E–01*	Low	Decrease in body weight in rats and mice
		Inorganics	
Cadmium	5.00E–04	High	Significant proteinuria in humans
Chromium	5.00–03	Low	No observed effects in rats
Lead	NR	--	--

a. USEPA - assigned level of confidence in toxicity value. Med = medium.

Note: UR = under review, NR = not reported. An asterisk (*) indicates that values were taken from USEPA 1992d. A dash ("--") indicates that this item is not applicable, or that there is no entry in either IRIS or HEAST.

TABLE 7 ORAL EXPOSURE SLOPE FACTORS AND TARGET ORGANS OF THE CHEMICALS OF CONCERN AT OU6, EIELSON AFB, ALASKA

Chemical	CAG[a]	Slope Factor $(mg/kg\text{-}d)^{-1}$	Target Organ (Tumor Type)
Organics			
Benzene	A	2.90E–02	Blood (leukemia): humans
Ethylbenzene	D	--	--
Toluene	D	--	--
Xylenes	D	--	--
Petroleum Hydrocarbons	U	--	
Diesel Hydrocarbons	D	--	
Gasoline Hydrocarbons	C	1,70E–03*	Liver (carcinoma/ adenoma): mice
Inorganics			
Cadmium	B1	--	Significant proteinuria in humans
Chromium	A	--	No observed effects in rats
Lead	B2	--	--

a. A CAG = EPA Carcinogen Assessment Group (see text).

Note: SF = slope factor, U = Undetermined. An asterisk (*) indicates that values were taken from USEPA 1992d. A dash ("--") indicates that this item is not applicable, or that there is no entry in either IRIS or HEAST.

There are no EPA toxicity classifications for two of the principal contaminants measured at OU6, TPH and lead, so these compounds were not included in the primary risk calculations. The relatively high concentrations of TPH at OU6 are believed to have resulted from past spills and leaks of fuel. Because of the inherent variability in the degradation of fuels in soil, no fixed toxicity value can be assigned. However, the sample with the highest TPH concentration at each site was also analyzed for volatile and semivolatile organic compounds, for which SFs and RfDs are established. Lead concentrations in groundwater and soils were compared to the EPA guidance value for soils (500 mg/kg) and the groundwater MCL (Maximum Contaminant Level) of 15 µg/L. The highest total concentrations of dissolved lead in groundwater at OU6 (6 µg/L) did not exceed the MCL.

6.1.4 Risk Characterization

The exposure point concentrations listed in Appendix F of the RA for the site were used with the toxicity data in Table 6 to calculate the risks for carcinogens and noncarcinogens at the OU6 site. For carcinogens, risks were estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen for the stipulated duration and frequency of exposure. Excess lifetime cancer risk was calculated with the following equation:

Risk = CDI x SF

where

Risk = a probability (e.g., 2E–5 [0.00002]) of an individual developing cancer
CDI = chronic daily intake averaged over 70 years (mg/kg-day)
SF = slope factor (mg/kg-day)-1

The probabilities of risk are generally expressed in scientific notation (e.g., 1×10^{-6}, or 1E-6). An excess lifetime cancer risk of 1E-6 indicates that, as a reasonable maximum estimate, an individual has a one in one million chance of developing cancer over a 70-year lifetime as a result of site-related exposure to the carcinogen under the specific exposure conditions at a site.

For noncarcinogens, the potential effects were evaluated by comparing the exposure level over a specified time period (e.g., 9 years, the average term of residence in a house) with a reference dose derived for that exposure period. The ratio of these two values is called a hazard quotient (HQ), and it represents in some sense the chance that the receptor will suffer symptoms of the toxicity. By adding the HQs for all contaminants of concern within a medium or across all media to which a given population may be exposed, the Hazard Index (HI) can be generated.

The HQ (for noncarcinogens) is calculated as follows:

HQ = CDI/RfD

where

CDI = chronic daily intake
RfD = reference dose

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

Risk calculations were made for each of the four land-use scenarios, all associated exposure pathways, and for two different exposure cases—"average exposure" and "reasonable maximum exposure."

Table 8 summarizes the risk calculation results for OU6. Each table lists the cancer risk and the HI for each exposure pathway separately. The values presented are for the RME (reasonable maximum exposure) case only. A total cancer risk value and a total HI are presented that add all of the exposure pathway risks together.

Metals other than cadmium, chromium, and lead were not considered to result from activities at the base: except for these three, there are no known human-caused sources of metals at OU6, so other metals detected in previous investigations were removed from the list of COC. The Fairbanks area of Alaska is known to have elevated concentrations of a number of metals in the groundwater, particularly iron, manganese, and arsenic, and many of these metals exceed risk-based screening concentrations at uncontaminated sites on Eielson AFB.

Table 8 indicates that the predicted excess cancer mortality associated with the future residential land-use scenario constitutes an unacceptable risk at OU6 and that the HI is greater than 1. The major exposure pathway of concern for the site under the local-drinking-water land-use scenarios is the inhalation of the vapors from contaminated groundwater.

The chief chemical of concern in groundwater at OU6 is benzene, although diesel hydrocarbons presented a hazard index greater than 1.

Ingestion of and dermal contact with contaminated surface soils and shallow sediments did not present an excess cancer risk greater than 1 x 10-6 (the highest combined value was about 2E–9), and the Hazard Index was well under 1, even in the future residential scenario.

6.1.5 Uncertainties in the Risk Assessment

Health risk assessment methodology has inherent uncertainty associated with the degree to which the calculated risk estimates represent the actual risk. The effects of the assumptions and the uncertainty factors may not be known. Usually, the effect is difficult to quantify numerically, so the effect is discussed qualitatively. Some of the major assumptions and uncertainty factors associated with the risk assessment are the following:

TABLE 8 TOTAL RECEPTOR RISK VALUES FOR CURRENT AND FUTURE LAND USE, OPERABLE UNIT 6, EIELSON AFB, ALASKA

	Hazard Index		Carcinogenic Risk	
Exposure Pathway	Average	RME[a]	Average	RME[a]
Current Camp Workers/Recreators				
Ingestion of Soil/Sediment	3.0E-03	3.0E-03	1.7E-11	5.8E-11
Dermal Contact with Soil/Sediment	1.5E-02	6.0E-02	5.4E-11	7.9E-10
Total Receptor Risk	2E-02	7E-02	7E-11	8E-10
Current Military Personnel				
Ingestion of Soil/Sediment	3.0E-03	3.0E-03	1.7E-11	4.8E-11
Dermal Contact with Soil/Sediment	3.0E-02	1.3E-02	1.1E-10	1.3E-09
Total Receptor Risk	3E-02	1E-01	1E-10	1E-09
Future Residents (Hypothetical)				
Ingestion of Groundwater	1.9E+00	3.4E+00	1.8E-05	1.1E-04
Volatiles	7.0E-03	7.0E-03	7.8E-04	3.3E-03
Dermal Contact with Groundwater	4.0E-03	7.0E-03	2.0E-06	1.0E-05
Ingestion of Soil/Sediment	1.0E-02	2.5E-02	4.8E-11	1.6E-10
Dermal Contact with Soil/Sediment	4.2E-02	1.9E-01	1.5E-10	1.7E-09
Total Receptor Risk	2E+00	4E+00	8E-04	4E-03
Future Military Personnel (Hypothetical)				
Ingestion of Groundwater				
Volatiles	1.2E+00	1.2E+00	1.2E-05	3.3E-05
Dermal Contact with Groundwater	5.0E-03	5.0E-03	3E-04	3.0E-03
Ingestion of Soil/Sediment	4.0E-03	5.0E-03	2.0E-08	7.0E-06
Dermal Contact with Soil/Sediment	3.0E-03	3.0E-03	1.7E-11	4.8E-11
Total Receptor Risk	3.0E-02	1.3E-01	1.1E-10	1.3E-09
	1E+00	1E+00	7E-04	2E-03

a. RME - Reasonable Maximum Exposure.

- The assessment used EPA Region 10 default exposure parameters for most calculations. Some of these parameters are not realistic for a subarctic climate (May overestimate risk.)

- Because the toxicity of TPH and lead has not been established neither was included in the primary calculations in the risk assessment. (May underestimate risk.)

- Existing concentrations are assumed to be the concentrations or exposure source terms in the future. No reduction through natural degradation and attenuation over time is taken into account. (May overestimate risk.)

- No increase through additional contamination is assumed. (May underestimate risk.)

- Potential degradation products of existing organic contaminants are not considered. (May overestimate or underestimate risk.)

- The groundwater detection limits for some organic and inorganic contaminants are higher than the risk-based screen concentrations. (May underestimate risk.)

- Contaminant concentrations in groundwater may be lower than the maximum concentrations because of the limited number of sample points in the permafrost and fractured bedrock. (May underestimate risk.)

6.2 ECOLOGICAL RISKS

The contaminants of concern at the OU6 site, benzene, toluene, ethylbenzene, xylenes, and lead, were found in the shallow and deep soil on the ridge beneath the locations of the former storage tanks and, to a certain extent, at the base of the ridge on the western side.

In planning the ecological risk assessment, it was concluded that since volatiles do not bioaccumulate, but lead may, depending on the complexing form, lead would be studied in the diet of various animals at the site.

Inhalation exposure of reference mammals and birds to volatiles (BTEX) from soil and ingestion exposure of herbivores and carnivores to lead were estimated. The endpoint was taken to be the lowest observable effect levels (LOEL) and concentrations (LOEC), for ingestion and inhalation, respectively. Because most toxicity work has been done on acute effects in domestic animals, large extrapolations with considerable uncertainties had to be made.

6.2.1 Habitat Types and Potential Receptors

The major habitat types in the area included forest, lawn (mown) grasses, and a small lake. Potential receptors included lemmings, voles, red squirrels, hares, beavers, porcupines, Canada geese, grouse, and ptarmigan (terrestrial herbivores); moose and various species of ducks (consumers of aquatic vegetation); and northern goshawk, red tailed hawk, great horned owl, and coyote (carnivores).

Representative local receptors (those expected to remain in the area through a lifetime) were chosen: grouse and voles for inhalation and ingestion of volatiles; and for ingestion of lead, voles in lawn habitat and shrews and shrikes in forest habitat.

Because no lead or volatiles were detected in the local pond, and volatiles in groundwater were found at depths of 30 ft or more below the ground surface, deeper than the root zones of shrubs and trees, surface water and groundwater are not plausible pathways and were not analyzed.

6.2.2 Sampling and Analysis of Diet Tissues

For evaluation of lead in the diet of reference herbivores and carnivores, plant and animal tissue samples (grass and tree parts, aquatic invertebrates, squirrel) were collected and analyzed for lead. Blank and spiked samples were analyzed to validate the samples.

6.2.3 Modeling Exposure

Inhalation Inhalation exposure was modeled for the maximally exposed terrestrial receptor, grouse, using a conservative assumption about diffusion of volatiles. The resulting estimated doses were as follows:

	Benzene	Ethylbenzene	Toluene	Xylenes
Dose (μg/kg[body weight]/day)	152	158	600	604

Ingestion Ingestion exposure was modeled with lead concentrations in the receptor's food, measured at the site, weighted by the proportion of the food in the diet and the proportion of food thought to come from the contaminated area, given the receptor's home range, taken from the literature. The following receptor doses were estimated for lead:

	Shrew	Shrike
Dose (μg [wet weight]/kg [body weight])	0.18	0.21

Ingestion LOEL and inhalation LOEC were estimated for mammals (volatiles) and for birds and mammals (lead) and used with estimated exposures to calculate EHQs (Exposure Hazard Quotients) for the receptor species. (A total EHQ was obtained by summing the component EHQs. A total EHQ near 1 was taken as evidence of potential ecological risk for biota at the site.)

6.2.4 Estimated Ecological Risk

The estimated EHQs for ingestion of lead were 0.004 for shrews and 0.008 for shrikes. The estimated total EHQ for ingestion of volatiles (BTEX) by grouse was 0.01 (that for benzene alone was 0.0008).

The estimated EHQ for voles exposed to volatiles by inhalation was 0.2, of which half the risk was due to toluene. A similar EHQ (0.2) was estimated for grouse exposed to volatiles by inhalation. These inhalation exposure risks were made quite conservative by the assumption that the volatiles did not rise more than 1 cm above the ground level.

In summary, the highest estimated EHQ for reference birds and mammals exposed to the contaminants of concern at OU6 was on the order of 0.2, and thus the site does not appear to present a significant ecological risk.

> Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision, may present an imminent and substantial endangerment to public health, welfare, or the environment.

7. DESCRIPTION OF REMEDIAL ALTERNATIVES

7.1 REMEDIAL ACTION OBJECTIVES

The Feasibility Study recommended that OU6 be considered for remedial action primarily because of the potential risk from unrestricted domestic use of groundwater containing contaminants derived from petroleum (BTEX). The Baseline Risk Assessment concluded that the greatest risks at OU6 are associated with benzene in the groundwater.

Soil The results from the site remedial investigations and the risk assessment indicated that contaminant concentrations present in the site soils are low and that there is currently no identifiable source of further groundwater contamination. Therefore, no remediation of the site soils was deemed necessary, and no remedial action objectives were developed for the site soils.

Groundwater The groundwater remedial action goals for the OU6 source area are the following:

- Prevent ingestion/direct contact with groundwater containing contaminants in excess of MCLs or having non-zero MCLGs.

- For contaminants for which there are no MCLs, prevent the inhalation of vapors from groundwater that contains carcinogens that could result in a cancer risk higher than 1E–4 to 1E-6.

- For contaminants for which there are no MCLs, prevent ingestion or direct contact with groundwater containing non-carcinogenic toxic substances at concentrations that could cause adverse effects (result in a Hazard Index of more than 1).

- Attain residual contaminant levels that would restore the groundwater as a potential source of drinking water.

The goal is to reach the concentrations described in the Safe Drinking Water Act ARAR (40CFR141) for volatile organics:

	Benzene	Toluene	Ethylbenzene
MCL (µg/L)	5	1,000	750

7.2 REMEDIAL ALTERNATIVES

Three alternatives were developed and thoroughly analyzed in the FS.

7.2.1 Alternative 1 - No Action

Under this alternative, no action would be taken to address groundwater contamination. It is considered as a baseline against which other alternatives can be compared. It is estimated that groundwater contamination would persist for more than 30 years. There are no costs associated with this alternative.

7.2.2 Alternative 2 - Limited Action

This alternative includes continued groundwater monitoring to detect and evaluate any changes in contaminant concentrations and implementation of institutional controls to prevent the use of the contaminated groundwater in the vicinity of the ski lodge from the existing water supply wells and the construction of any new wells.

Institutional land use controls would be designed to prevent exposure to contaminated groundwater. The controls would include posting the area and prohibiting the installation and use of any well for drinking water that could extract contaminated groundwater or affect the movement of contaminated groundwater. Figure 7 shows possible locations of signs explaining the restricted use of groundwater.

Use of the groundwater will be prohibited until it is shown to reach drinking water standards with respect to petroleum products.

Wells at the site would be monitored as part of the Eielson AFB Site-Wide Monitoring Plan, to continue evaluation of the fate and transport of contaminants at OU6.

The details of monitoring and evaluation will be developed in the Site-Wide Monitoring Plan documents.

For the purposes of estimating costs, periodic monitoring of groundwater is assumed to continue for 30 years. Present worth costs are estimated at $370,000.

7.2.3 Alternative 3 - *In Situ* Treatment Using Air Sparging with Vapor Extraction or Enhanced Bioremediation

Alternative 3 would involve an in situ remedial technology consisting of air sparging or bioremediation. Air sparging is the use of injection wells to inject air into the groundwater. The injected air would promote the transfer of the volatile organic compounds such as benzene and petroleum hydrocarbons from the groundwater to the soil above, where they would be extracted through vapor extraction wells (Alternative 3a), or the air injection can be used to enhance native microbial activity in the saturated zone and the vadose zone, which degrades the petroleum-related contaminants (Alternative 3b). The layout of a remedial system for these two alternatives is shown in Figure 8.

Alternative 3 would also include implementation of institutional controls, as described for Alternative 2, and a groundwater monitoring plan to track the status of the contamination and attainment of the ARARs, shown above for Alternative 2.

Because this alternative would involve injection of air to the subsurface, air emissions from the subsurface would be expected. Air emissions of 250 tons per year or more of an air

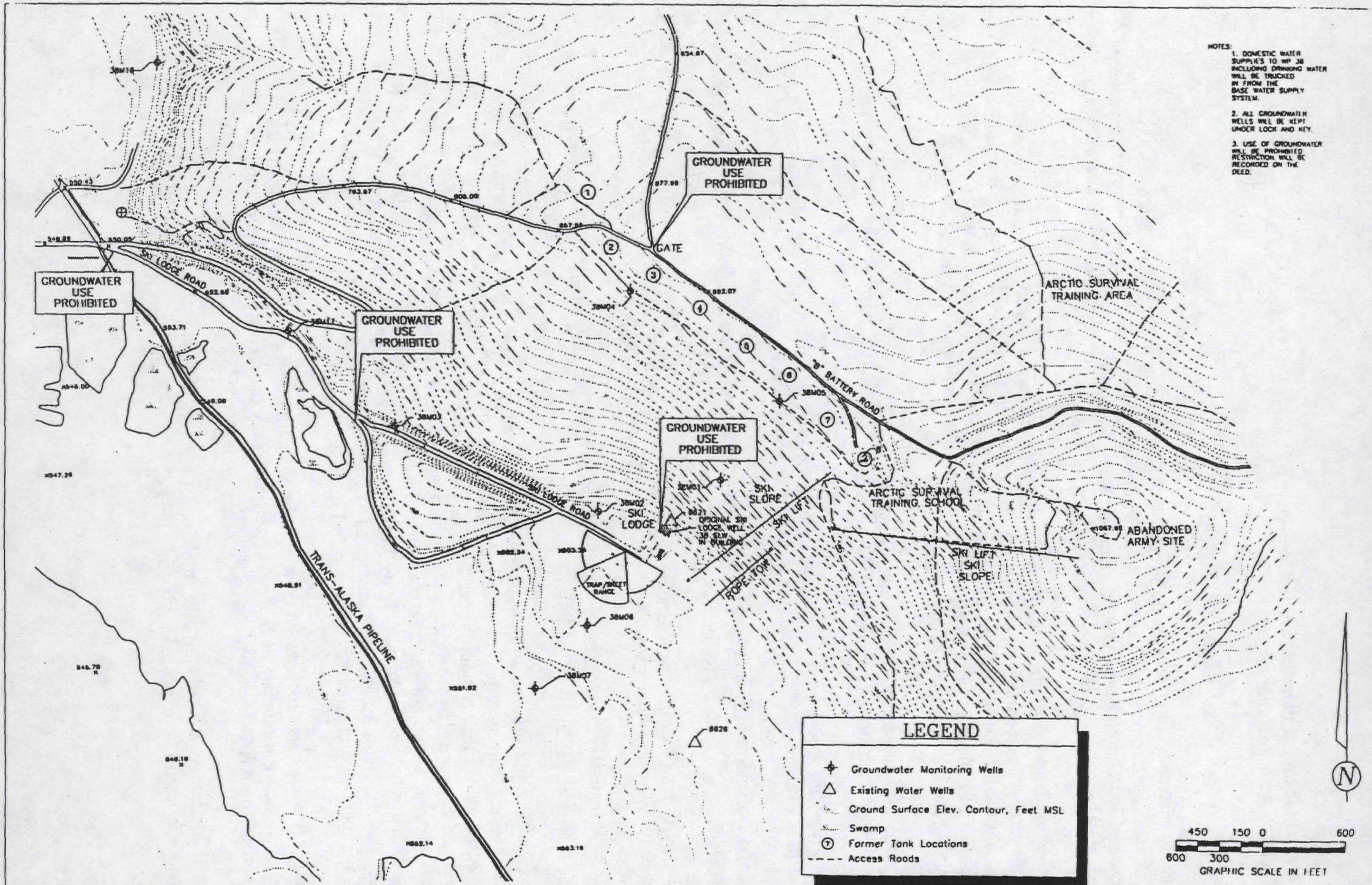

Figure 7. Approximate locations of institutional controls and existing monitoring and water supply wells, Alternative 2, OU6, Eielson AFB, Alaska.

Drawn:	Date:
Reviewed:	Date:
Rev.1:	Date:
Final:	Date:

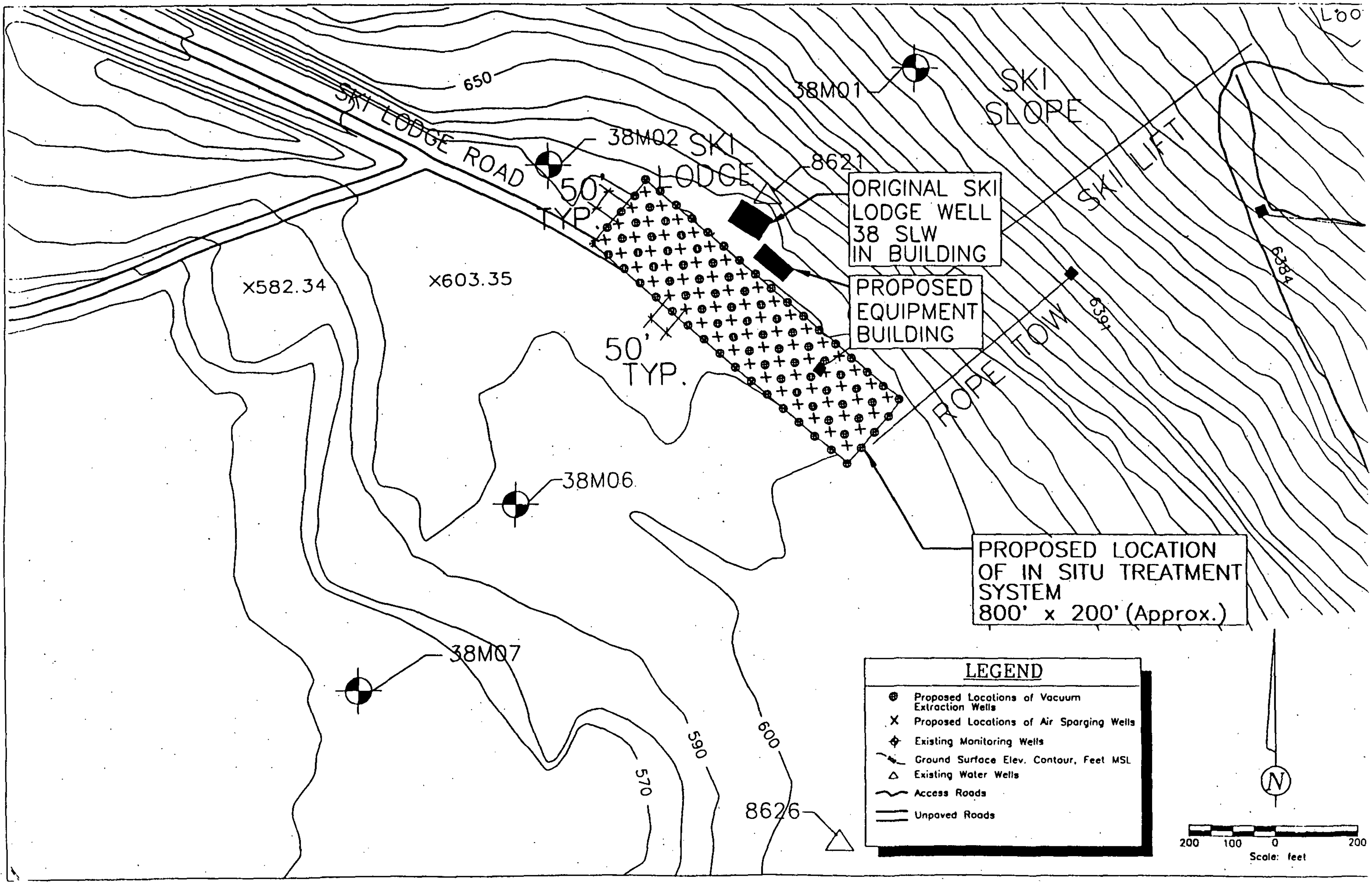

Figure 8. Remedial alternative, OU6, Eielson Air Force Base, Alaska.

Drawn:	Date:
Reviewed:	Date:
Rev. 1:	Date:
Final:	Date:

contaminant regulated under the Clean Air Act (as amended) would require a permit to operate under 18 AAC 50.300.

Based on available information and modeling, the period for remediation is estimated to be between 10 and 30 years. The present worth costs are estimated to be between $5 million and $10 million.

8. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

In accordance with federal regulations, the three cleanup alternatives were evaluated on the basis of the nine criteria for choosing among remedial alternatives presented in the NCP (Table 9).

8.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1 is not protective of human health and the environment, because no action would be taken to address groundwater contamination and no controls would be implemented to prevent use of the groundwater.

Alternatives 2 and 3 would use institutional controls to prevent the use of contaminated groundwater until cleanup standards are achieved. If the treatment technology is found to be effective in addressing the groundwater contamination, Alternative 3 would likely achieve cleanup standards in less time than Alternative 2.

8.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Alternatives 1 and 2 would rely on natural processes to decrease contaminant concentrations in groundwater. Drinking water standards would not be met in the vicinity of the ski lodge for several decades.

Alternatives 1 and 2 are expected to attain Federal and State groundwater cleanup levels through natural attenuation (dispersion, dilution, degradation). However, in the interim, groundwater contaminant levels would continue to exceed MCLs and pose a threat to human health and the environment.

Because Alternative 3 includes groundwater treatment, it should, in principle, achieve groundwater cleanup standards more rapidly. The treatment system described in Alternative 3 would be designed and implemented so as to meet all applicable or relevant and appropriate state and federal environmental regulations (ARARs), including air emission limitations.

8.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

All alternatives will result in the decay of hydrocarbons by natural attenuation processes and will result in the attainment of MCLs in the long term.

Alternative 3 would actively address the problem of contaminated groundwater and could result in remediation more quickly than the other two alternatives. However, because of the uncertainty associated with remediating contaminants in fractured bedrock, it is difficult to predict whether the treatment would be effective. It is difficult to monitor a contaminant "plume" in a fractured bedrock aquifer, because flow of the contaminants could be controlled by a small number of hydrologically significant fractures. These are difficult to locate and identify using conventional field methods and a reasonable density of sampling points.

TABLE 9 CRITERIA FOR SELECTION OF ALTERNATIVE REMEDIES FOR CERCLA SITES

Criterion	Questions for Meeting Criterion
	Threshold Criteria
Overall protection of human health and environment	How well does the alternative protect human health and the environment, both during and after construction?
Compliance with requirements	Does the alternative meet all applicable or relevant and appropriate state and federal laws?
	Balancing Criteria
Long-term effectiveness and permanence of treatment	How well does the alternative protect human health and the environment after completion of cleanup? What, if any, risks will remain at the area?
Reduction of toxicity, mobility, and volume	Does the alternative effectively treat the contamination to significantly reduce the toxicity, mobility, and volume of the hazardous substance?
Short-term effectiveness	Are there potential adverse effects to either human health or the environment during construction or implementation of the alternative? How fast does the alternative reach the cleanup goals?
Implementability	Is the alternative both technically and administratively feasible? Has the technology been used successfully at similar areas?
Cost	What are the relative costs of the alternative?
	Modifying Criteria
State acceptance	What are the state's comments or concerns about the alternative considered and about the preferred alternative? Does the state support or oppose the preferred alternative?
Community acceptance	What are the community's comments or concerns about the alternative considered and about the preferred alternative? Does the community generally support or oppose the preferred alternative?

8.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternatives 1 and 2 do not include treatment of contaminants at OU6. Alternative 3 would reduce the total mass of contaminants in the groundwater through active treatment.

8.5 SHORT-TERM EFFECTIVENESS

Alternative 1 would not be protective of the community.

The implementation of Alternative 3 would not be expected to pose an unacceptable risk to residents or workers. All potential impacts from construction and operation of the system would be readily controlled using standard engineering controls and practices. Although Alternative 3 would include groundwater treatment, it is not certain that treatment would be able to achieve cleanup standards faster than natural processes, because of the site's hydrogeological conditions, contaminant release history, and contaminant migration and degradation processes.

None of the alternatives is expected to pose an unacceptable risk to residents or workers during implementation. All potential impacts from the system's construction and operation will be readily controlled using standard engineering controls and practices.

8.6 IMPLEMENTABILITY

Alternative 1, requiring no further action, would be the easiest to implement.

Alternative 2 would be readily implemented because the institutional controls and groundwater monitoring would involve no appreciable administrative or technical difficulties.

Although Alternative 3 is technically feasible, it would require a phased approach to verify the performance of the treatment system and to determine sizing criteria for the remedial design. Furthermore, although air sparging/enhanced bioremediation treatment is a frequently used technology, implementation in fractured bedrock is sometimes attended with unexpected difficulties.

8.7 COST

Based on the information available at the time the alternatives were developed, the estimated present value cost, in thousands of dollars, of the alternatives, assuming 7 percent interest rate for 30 years, are the following:

	Alternative 2	Alternative 3	
	Limited Action	Air Sparging	Bioremediation
Capital Cost ($1,000s)	30	3,800	2,600
Present Worth of Total Cost ($1,000s)	370	7,485	6,375

8.8 STATE ACCEPTANCE

The State of Alaska Department of Environmental Conservation concurs with the selection of Alternative 2 as the remedial alternative. ADEC has been involved throughout the RI/FS process, and the agency's comments have been considered and incorporated in this ROD.

8.9 COMMUNITY ACCEPTANCE

Comments received during the public meeting and during the public comment period were considered in selecting the final remedial alternative. Alternative 1 had no proponents, and doubts were expressed about the efficacy and cost-effectiveness of Alternative 3. The community response to the remedial alternative is presented in the Responsiveness Summary, which addresses comments received during the public comment period.

9. THE SELECTED REMEDY

The preferred alternative is Alternative 2: Limited Action. The Air Force, EPA, and ADEC selected this alternative over the other alternatives after evaluating the nine CERCLA criteria described in Table 9. As described in Sections 7 and 8, Alternative 2 consists of institutional controls to prevent current and future exposure to the contaminated groundwater, along with groundwater monitoring.

9.1 INSTITUTIONAL CONTROLS

The selected remedy uses institutional controls to prevent current and future exposure to the contaminated groundwater. Institutional controls include measures undertaken to limit or prohibit activities that may result in exposure to hazardous substances in the groundwater at a site. At this site, institutional controls governing land use will prohibit extraction and use of groundwater.

9.2.1 Land Use Controls

The land use controls,which will govern use of the land and groundwater as long as it is under the jurisdiction of the Air Force, will be prepared by Eielson AFB and submitted to ADEC and EPA for approval.

Restrictions on the use of groundwater will include the following elements:

1. a property or site map showing the areas currently or potentially impacted by groundwater contaminants at OU6

2. a prohibition on the installation and use of any well that could extract groundwater contaminants or affect the movement of groundwater contaminants located beneath OU6

3. a prohibition of any activity that may interfere with groundwater monitoring activities including, but not limited to, maintenance of monitoring wells, installation of new monitoring wells, and groundwater sampling

4. a prohibition of any activity that may result in the release of contaminants to groundwater

5. a requirement of notice to and approval by ADEC and EPA of any proposal to add to or alter land use controls

6. a requirement to notify ADEC and EPA of any proposal to change the existing land use at OU6.

This will be implemented by posting signs, continuing to provide portable water to the site from the base water system, and controlling access to all existing wells.

In addition, to ensure the long-term integrity of the above land-use controls, the Air Force will make sure that, to the extent that groundwater contamination remains above unacceptable levels, deed restrictions or equivalent safeguards will be implemented in the event property containing such contamination is transferred by the Air Force.

9.1.2 Transfer of Property

Conveyance of title, easement, or other interest in the real property subject to this ROD shall be in accordance with Section 120(h) of CERCLA, 42 U.S.C. § 9620 (h).

9.1.3 Implementation Schedule

Within three months after final approval of the ROD, Eielson AFB shall implement and develop a means to ensure the long-term integrity of the institutional controls.

9.2 GROUNDWATER MONITORING

Groundwater monitoring at OU6 will be done as part of the Eielson AFB Site-Wide groundwater monitoring to be implemented in the 1994 field season. Specific monitoring parameters, such as wells to be sampled, parameters to be analyzed, and frequency of monitoring, will be defined in the Sampling and Analysis Plan (SAP) for the Site-Wide Groundwater Monitoring Plan. Results of the site-wide groundwater monitoring will be reported annually.

9.3 STATUTORY REVIEW

Because the selected alternative will result in hazardous substances remaining in the groundwater at the site above health-based levels, a review will be conducted within 5 years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Under provisions of the site-wide monitoring plan, the Sampling and Analysis Plan for OU6 will be updated periodically. The SAP will describe the location of samples to be collected, the analytes that will be tested, and the frequency of sample collection. Changes to the SAP may be made as appropriate, based on review of the monitoring data. If the data indicate movement of contaminants in a downgradient direction, measures will be taken to maintain effective knowledge of the extent of the contaminant plume.

10. STATUTORY DETERMINATIONS

The selected remedy meets statutory requirements of Section 121 of CERCLA, as amended by SARA, and, to the extent practicable, the NCP. The evaluation criteria are discussed below.

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy protects human health and the environment through the prevention of access to contaminated groundwater. Groundwater contaminated with VOCs (volatile organic compounds) will be remediated through natural attenuation, because the site is remote from developed areas, the contaminants are confined largely in the cracks in fractured bedrock (schist), and the prospects of success with active treatment of contaminants are not regarded as being very good.

Institutional controls will eliminate the threat of exposure in groundwater through ingestion and inhalation by preventing utilization of it. Natural attenuation will eventually reduce the contaminants in the groundwater to levels at which institutional controls are no longer necessary.

The estimated RME (reasonable maximum exposure) risk without remediation for residential land use from these exposure pathways was 4E–3 for carcinogenic risk and an HI (hazard index) of four for noncarcinogenic risks. The corresponding future industrial land use for military personnel had a risk value of 2E–3 (0.002) and a Hazard Index of 1.2. The goal for remediation through natural attenuation is cancer risks reduced to 1E–6 and an HI reduced to 1.

10.2 ATTAINMENT OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS OF ENVIRONMENTAL LAWS (ARARS)

The selected remedy is expected to comply with all applicable or relevant and appropriate requirements (ARARs) of federal and State of Alaska environmental and public health laws.

10.2.1 Applicable or Relevant and Appropriate Requirements (ARARs)

The remedy chosen for the site will comply with all action-, chemical-, and location-specific ARARs, listed below:

10.2.1.1 Action-Specific ARARs

There are no action-specific ARARs required for the selected alternative.

10.2.1.2 Chemical-Specific ARARs

- MCLs and non-zero maximum contaminant level goals (MCLGs) established under the Safe Drinking Water Act are relevant and appropriate requirements for groundwater that is a potential drinking water source:

	Benzene	Toluene	Ethylbenzene	Xylenes
MCL (μg/L)	5	1,000	700	10,000

- Alaska Water Quality Standards for Protection of Class (1)(A), Water Supply, Class (1)(B), Water Recreation, and Class (1)(C), Aquatic Life and Wildlife (18AAC70).

10.2.1.3 Location-Specific ARARs

There are no location-specific ARARs for the selected alternative.

10.2.2 Information-to-be-Considered

There is no Information-to-be-Considered for the selected alternative.

10.3 COST-EFFECTIVENESS

The selected remedy is cost-effective because it has been determined to provide overall effectiveness proportionate to its costs and duration for remediation of the contaminated groundwater. Alternative 3 with a present worth cost of $7.5 million or $6.4 million, is significantly more costly than the selected remedy. Given the uncertainty about the effectiveness of air sparging and enhanced bioremediation in fractured rock aquifers, the benefits of active remediation do not justify the additional cost.

10.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The U.S. Air Force, the State of Alaska, and EPA have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in cost-effective manner at the OU6 site. Of those alternatives that are protective of human health and the environment and comply with ARARs, the U.S. Air Force, the State of Alaska, and EPA have determined that the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, cost (as discussed in the preceding section), and the statutory preference for treatment as a principal element and considering State and community acceptance.

All alternatives would use readily available technologies and would be feasible to construct. Alternatives 1 and 2 would be readily implementable; they require no additional remedial action. The technologies involved in Alternative 3 are relatively limited in scope.

The most decisive factors in the selection decision were long-term effectiveness and implementability. Alternative 2 provides the best option for cost-effective and practical remediation of OU6, because it is expected that petroleum hydrocarbons will be released slowly from the bedrock into the alluvial aquifer over a potentially long period of time and that the processes of natural attenuation in the alluvial aquifer will suffice to reduce the concentrations from the bedrock aquifer below MCLs. Alternative 3 would in principle reduce the concentrations of contaminants in the bedrock aquifer more quickly, but the improvement, given the nature of the technology and the geologic and hydrologic conditions at the site, are not believed to be cost-effective. Regular monitoring will be done to ensure that the release rate is low enough to protect human health and the environment.

11. REFERENCES

Battelle. 1992. *Remedial Investigation/Feasibility Study -- Operable Units 3, 4, and 5 Management Plan, Eielson Air Force Base, Alaska.* Battelle, Environmental Management Operations, Richland, Washington. (Final).

CH2M Hill. 1982. *Installation Restoration Program Records Search for Eielson Air Force Base, Alaska.* CH2M Hill, Gainesville, Florida.

EPA. 1991. *Supplemental Guidance for Superfund Risk Assessments in Region 10.* U.S. Environmental Protection Agency, Seattle, Washington.

EPA, ADEC, and U.S. Air Force. 1991. *Eielson AFB Federal Facility Agreement under CERCLA Section 120*, EPA Docket Number: 1089-07-14-120.

HLA (Harding Lawson and Associates). 1989. *Installation Restoration Program Remedial Investigation/Feasibility Study, Stage 3, Eielson Air Force Base, Draft Remedial Investigation/Feasibility Study, Volume II (July 1988 to April 1989).* Harding Lawson Associates.

HLA (Harding Lawson and Associates). 1990. *Installation Restoration Program Remedial Investigation/Feasibility Study, Stage 4, Draft Remedial Investigation/Feasibility Study, Volumes I through V.* Harding Lawson Associates.

HLA (Harding Lawson and Associates). 1991. *Installation Restoration Program Remedial Investigation/Feasibility Study, Stage 4, Draft Remedial Investigation/Feasibility Study, Volumes VII through XVIII.* Prepared by Harding Lawson Associates.

Krumhart, A.P. 1982. *Hydrologic Information for Land-Use Planning, Badger Road Area, Fairbanks, Alaska.* Water-Resources Investigation 82-4097. U.S. Geological Survey.

USAF (U.S. Air Force). 1991. Community Relations Plan for Environmental Restoration, Eielson Air Force Base. Prepared by Eielson Air Force Base, Alaska.

USAF (U.S. Air Force). 1993a. *Background Soil Quality, Eielson Air Force Base, Alaska.* Battelle, Environmental Management Operations, Richland, Washington (Final).

USAF (U.S. Air Force). 1993b. *Background Groundwater Quality, Eielson Air Force Base, Alaska.* Battelle, Environmental Management Operations, Richland, Washington (Final).

USAF (U.S. Air Force). 1994a. *Eielson Air Force Base OU6 Remedial Investigation/ Feasibility Study: Remedial Investigation Report* (Final). Engineering-Science, Richland, WA.

USAF (U.S. Air Force). 1994b. *Eielson Air Force Base OU6 Remedial Investigation/ Feasibility Study: Baseline Risk Assessment* (Final). Engineering-Science, Richland, WA.

USAF (U.S. Air Force). 1994c. *Eielson Air Force Base OU6 Remedial Investigation/ Feasibility Study: Feasibility Study* (Final). Engineering-Science, Richland, WA.

USAF (U.S. Air Force). 1994d. *Proposed Plan for Operable Unit 6 and Other Areas* (Final). Engineering-Science, Richland, WA.

Weddleton, J., H. Richards, and R. Seifert. 1989. *Building in Alaska. A Guide for Assessing Risks and Costs of Water Well Drilling in the Fairbanks Area.* Cooperative Extension Service University of Alaska Fairbanks, Fairbanks, Alaska.

EIELSON AIR FORCE BASE
OPERABLE UNIT 6

RESPONSIVENESS SUMMARY

A. OVERVIEW

The proposed cleanup alternatives considered by the US Air Force, Alaska Department of Environmental Conservation (ADEC), and US Environmental Protection Agency (EPA) were presented to the public in a proposed plan (U.S. Air Force 1994) and discussed in a public meeting on 12 April 1994. This plan proposed alternative 2, limited action, as the preferred method to address the fuel-contaminated groundwater in the bedrock under the ski hill at Operable Unit 6. The preferred alternative makes the current restrictions on any use of groundwater in the area an institutional control. The controls will remain in effect as long as the contamination persists.

Public comments generally supported the plan as the best compromise among cleanup options.

These Sections Follow:

Background on Community Involvement
Summary of Public Comments From Comment Period and USAF Response
- Part I: Summary and Response to Local Community concerns
- Part II: Response to Technical and Legal Questions

B. BACKGROUND ON COMMUNITY INVOLVEMENT

Prior to being added to the EPA National Priority List in 1989, there was little opportunity for community involvement in environmental activity at Eielson AFB. From 1982 until 1989, the Air Force used the Installation Restoration Program (IRP) to identify potential contaminated areas and investigate what remedial actions might be required. This was purely technical and did not evaluate community concerns in the decision-making process. However, after signing a Federal Facility Agreement with the State of Alaska and the US EPA, the Air Force began its Superfund cleanup program, which includes extensive community involvement.

A Technical Review Committee was established in 1992 including three representatives from the community (selected by local officials and the University of Alaska Fairbanks Chancellor), industry representatives, and environmental agency representatives. Many of the TRC participants are members of the professional public.

The Proposed Plan for Operable Unit 6 was advertised three times in two local papers. In addition, more than 3,500 copies were added as an insert in the base newspaper and delivered to every home in the Eielson AFB housing area. A news release announcing the Proposed Plan and public meeting was sent to all local news media (radio, TV, newspapers) and the story ran on the front page of the base newspaper. The meeting was advertised on the base access cable channel and in the base information bulletin as well as at least two local area radio stations. Copies of the plan were delivered to various information repositories, plus North Pole City Hall. Flyers were placed in store bulletin boards in Moose Creek, North Pole and Salcha communities.

C. SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD AND USAF RESPONSES

The public comment period on the Operable Unit 6 Proposed Plan was held from 22 March until 22 April 1994. Comments received during that period are summarized below. Part I addresses non-technical concerns, while Part II responds to technical and legal questions. Each part is grouped by similar topics.

PART I - Summary and Response to Local Community Concerns

- **Topic:** Water Quality Downstream in Moose Creek

- **Public Comment:** One person was concerned that carcinogens from contamination at OU6 could create a cancer risk for residents in Moose Creek, if they hadn't already done so. The commenter indicated they knew a person who has cancer and wanted to know if the contamination from Eielson could have caused this, and what the base was doing to protect Moose Creek residents.

- **USAF Response:** The base has identified areas of suspected contamination and determined the limits of contamination for those sites using monitoring wells, soil sampling, sediment sampling, and surface water monitoring. The data appear to show isolated areas of contamination, which test cleaner with distance from the source areas. As an additional measure, the base installed a series of monitoring wells along the north boundary, adjacent to the Moose Creek community. These wells show no evidence of contamination even reaching the base boundary, so it appears unlikely any contamination is leaving or has left the base due to contamination migrating through the soil or groundwater. Surface water sampling of Garrison Slough and French Creek along the base boundary also show that water leaving the base meets all state and federal water quality standards. This water quality monitoring will continue for both groundwater and surface water throughout the base and along the boundary, in particular. While this cannot confirm there were no releases in the past before testing and sampling began, there is nothing now to suggest any contaminants left the base that would have affected residents of Moose Creek community.

- **Topic:** Alternatives Selection

--**Public Comment:** A person called with comments supporting the preferred alternative. The commenter was opposed to spending any money on a cleanup that was not a proven, effective technique when current conditions posed no threat to human health. They believed nature would heal itself best if man just left it alone. The caller approved of monitoring plans to make sure contamination didn't spread from the area.

-- **USAF Response:** The caller was knowledgeable of early conditions at the site and provided additional information regarding early activity associated with the refueling system. The caller said there were diesel generator-driven pumps to move the fuel in the first year of operating the system. The pumps caused too much pressure in the fuel lines and they leaked, so the system was made a gravity-feed only from the second year on. The base community relations officer met with the individual personally following the call. The Eielson cleanup team appreciates this type of community involvement and recognizes the community is a valuable source of new information about site conditions.

- **Topic:** Environmental Commitment Questioned

- **Public Comment:** One person commented they were not sure how sincere the Air Force was regarding cleanups. Caller felt if the Air Force really cared about the environment they would clean more sites instead of finding contamination and doing nothing about it. Caller's comments were not limiting this to OU6, but to all work on base, particularly underground tank removals. The commenter said they heard of a case where the Air Force removed a tank and found contaminated soil but put clean fill in the hole and closed it up with no action.

- **USAF Response:** The Air Force is dedicated to protecting the environment, and Eielson is fully committed to environmental cleanup. This is demonstrated by the funding as well as increased staffing to address environmental issues. Because Eielson is a Superfund site, all environmental operations are reviewed by the EPA and ADEC to make sure all commitments are met.

Underground storage tank removal operations at Eielson AFB are performed in concurrence with Alaska state LUST regulations. The general procedure for underground storage tank removal under the Alaska state LUST program is as follows:

- The storage tank is excavated and removed

- A Site Assessment is performed by an independent contractor

- If the Site Assessment indicates:
  - a spill has occurred and the spill is confined to the area above the water table, the contaminated soils are removed and replaced with clean fill dirt. No further action is taken at the site.

  - a spill has occurred and the spill extends to the water table, soils are excavated to the water table and the hole backfilled with clean fill dirt. Further action will be taken.

  - a spill has occurred and the spill extends beneath a building or structure, as much contaminated soil as possible is removed as far as the water table and the hole backfilled with clean dirt. Further action will be taken.

- In the event of a release, a Release Investigation is performed in which soil borings are made and samples taken to delineate the contaminant plume. If a plume is detected, monitoring wells are installed and sampling is performed to determine the extent of groundwater contamination. If contaminant levels require remedial action, the site will undergo a study similar to studies conducted under CERCLA superfund requirements. A remediation alternative action will be selected in agreement with the state and the site will undergo cleanup action.

In 1992, three underground storage tanks were excavated and removed from service at the base BX service station. A Release Investigation by an independent contractor indicated a release had taken place and that petroleum contamination did extend to the water table. The holes were backfilled with clean fill dirt and 10 monitoring wells were placed in the vicinity of the service station. Groundwater analysis in 2 of the 10 wells did indicate groundwater contamination at the site from the petroleum release. The level of contamination was above state action levels. After conferring with the state regulatory agency, the site was placed under continued monitoring to determine if the natural attenuation process will reduce the contaminants to below action levels. If future groundwater analysis indicates additional action is required to address contamination at the site, Eielson AFB and the state regulatory agency will determine which remediation alternative action will be selected to correct the problem. This is the only site on the base where a release from an underground storage tank has contributed to groundwater contamination.

PART II - Response to Specific Technical and Legal Questions

- **Topic:** Risk-Based Cleanup Levels for Soil Contamination

- **Public Comment:** One person had several questions. They wanted to know if all areas of soil contamination (in excess of ADEC cleanup levels) had been identified. They asked if there were any areas where soil contamination was contributing to groundwater contamination. They wanted to know if there were any releases due to the now-removed pipeline that served the tanks on the hilltop.

- **USAF Response:** In the initial IRP investigation conducted in 1989, 64 potentially contaminated sites were identified at Eielson AFB. The individual sites were assigned to an operable unit based on the type of contamination present or designated as a SER site for further study and evaluation. Any additional sites located following the initial IRP investigation are designated as Areas of Concern (AOCs). Each AOC is to be evaluated on an individual basis to determine if contamination is present. A continuing study of past and present activities at Eielson AFB is ongoing in an effort to identify and address any potentially contaminated site at Eielson AFB not identified in the initial IPR investigation.

Soil contamination is contributing or has a potential to contribute to groundwater contamination at a number of sites at Eielson AFB. Remediation projects and removal actions directed at contaminant removal from the soil are in current progress at several sites on base. Present monitoring of groundwater at these sites shows groundwater contaminants to be confined within the areas of the sites. Continued long-term monitoring of the groundwater at these sites will provide information on contaminant removal through remedial action or through natural attenuation and will serve as a safeguard to indicate contaminant migration off site, if this should occur. Regular monitoring of base boundary wells are an additional safeguard to alert EAFB and the regulatory agencies of contaminant plume migration. This will allow adequate time to apply appropriate cleanup alternatives to prevent migration of contaminants beyond base boundaries.

Releases of fuel from the pipeline serving the former tank farm at Operable Unit 6 were a problem which prompted a decision to convert the pipeline from a pump-charged system to a gravity flow system. Although releases were noted during the operational life of the pipeline system, documentation regarding leaks and spillage history in the pipeline area was not precise, and actual spillage or leaking volumes are unknown. Because no reports exist which indicate large spillage volumes associated with the pipeline, the Remedial Investigation focused primarily on the tank farm leakage at the top of the hill. Site geology studies indicate fuel spills associated with the pipeline would have characteristically followed the same migration pathway as the fuel leaking from the tanks at the top of the hill, presumably straight down to the underlying fractured schist bedrock.

Attachment A

COMMUNITY RELATIONS ACTIVITIES
At Eielson Air Force Base Alaska

1982	Eielson conducts records search and interviews to identify environmental problem areas under Air Force Installation Restoration Program.
1983–1989	Eielson AFB environmental investigations identify contamination.
Nov. 1989	Eielson AFB listed on EPA National Priority List for priority cleanup.
May 1991	Eielson AFB signs Federal Facility Agreement with EPA and ADEC.
Oct. 1991	Eielson AFB holds first public meeting to announce Superfund cleanup.
Oct. 1991	Community Relations Plan released.
Jan. 1992	Administrative Record established at University of Alaska Fairbanks library.
May 1992	Technical Review Committee established,including three community representatives from North Pole, Fairbanks, and the University of Alaska, Fairbanks.
Jun. 1992	Public meeting on Operable Unit 1B proposed plan.
Dec. 1992	Public meeting on Record of Decision for OU-1B (Signed in Sep 92).
1992–1993	Interviews with 40 community members to update Community Relations Plan.
Jan. 1993	International Bioventing Symposium held at Eielson for innovative technology.
Sep. 1993	Video documentary on base environmental program released, aired on base TV.
Nov. 1993	Public meeting on OU-2 Proposed Plan and SER Phase 1 recommendations.
Apr. 1993	Public meeting on OU-6 Proposed Plan and Removal Actions for three sources.

In October 1991, Eielson AFB released its Community Relations Plan at the first environmental cleanup public meeting. In subsequent public meetings in 1992 and 1993, Eielson presented the Proposed Plans for Operable Unit 1B and Operable Unit 6, and discussed upcoming removal actions.

From 1992 through 1993, surveys and interviews of more than 100 community residents were used to update the Community Relations Plan. Eielson AFB prepares fact sheets on topics like water quality, Technical Assistance Grants, Information Repositories, cleanup technologies and work opportunities to keep the public advised on cleanup activity. These are available at the information repositories, or by contacting the community relations point of contact.